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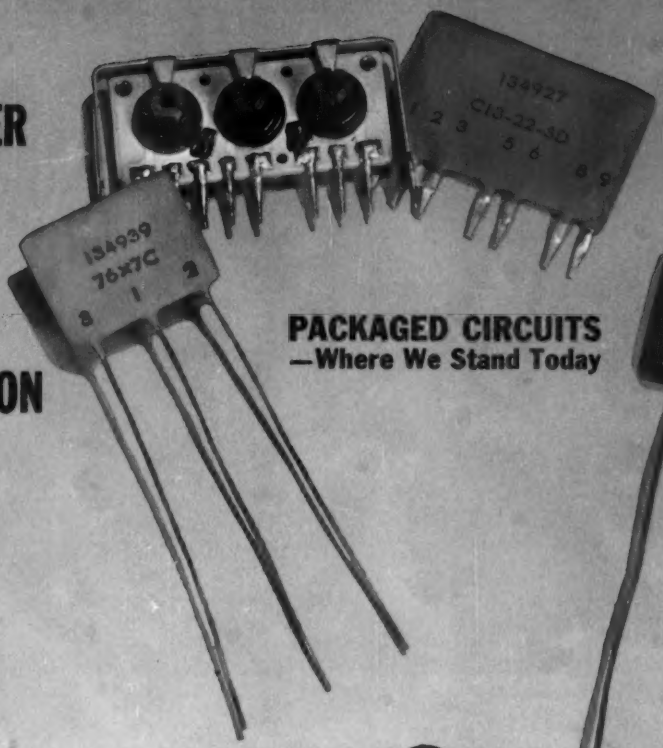

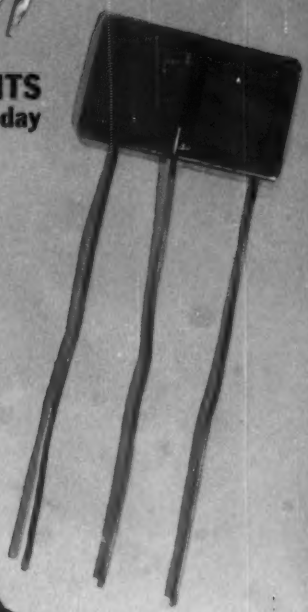

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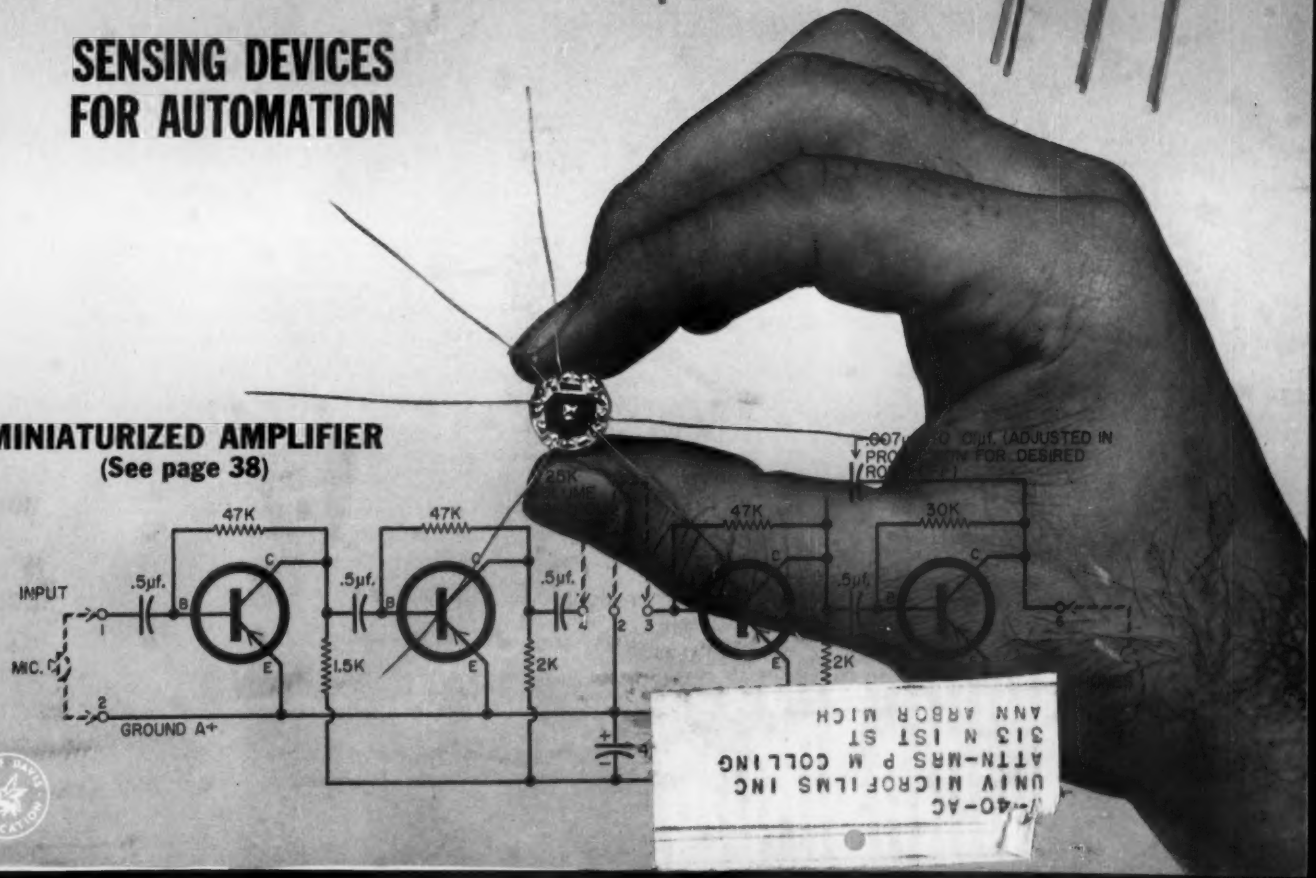

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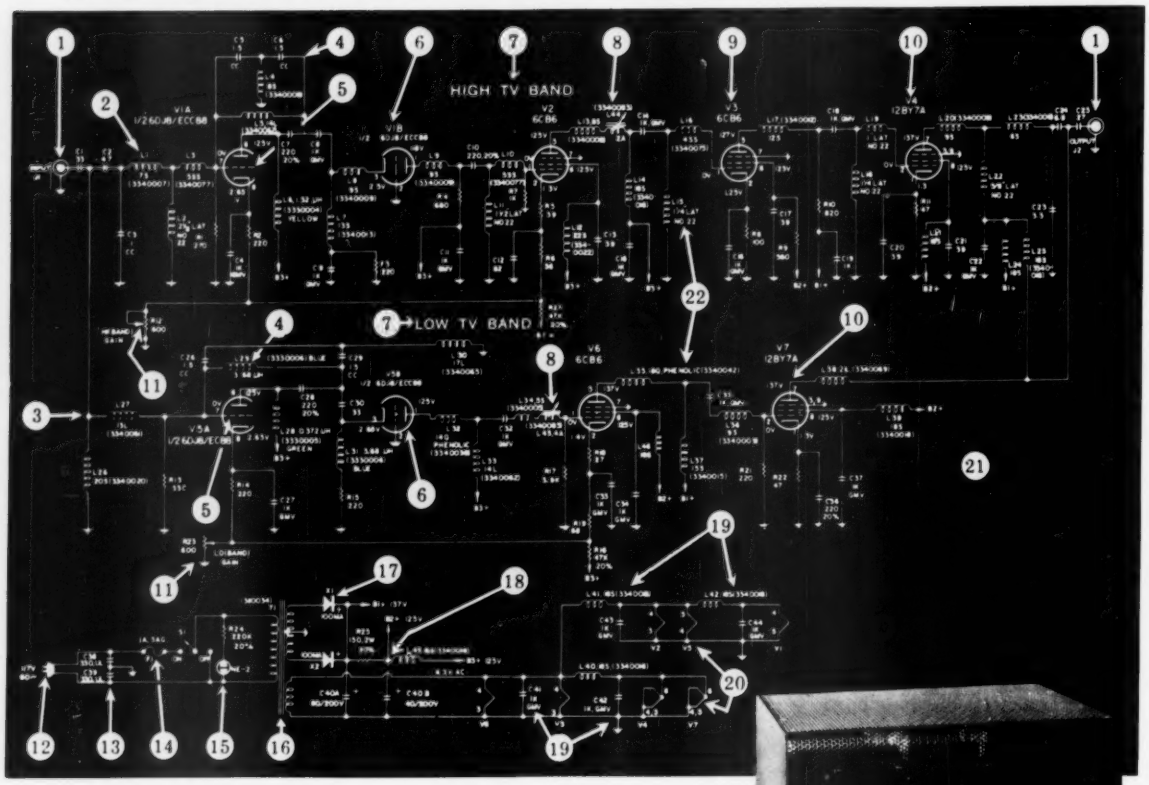

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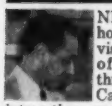

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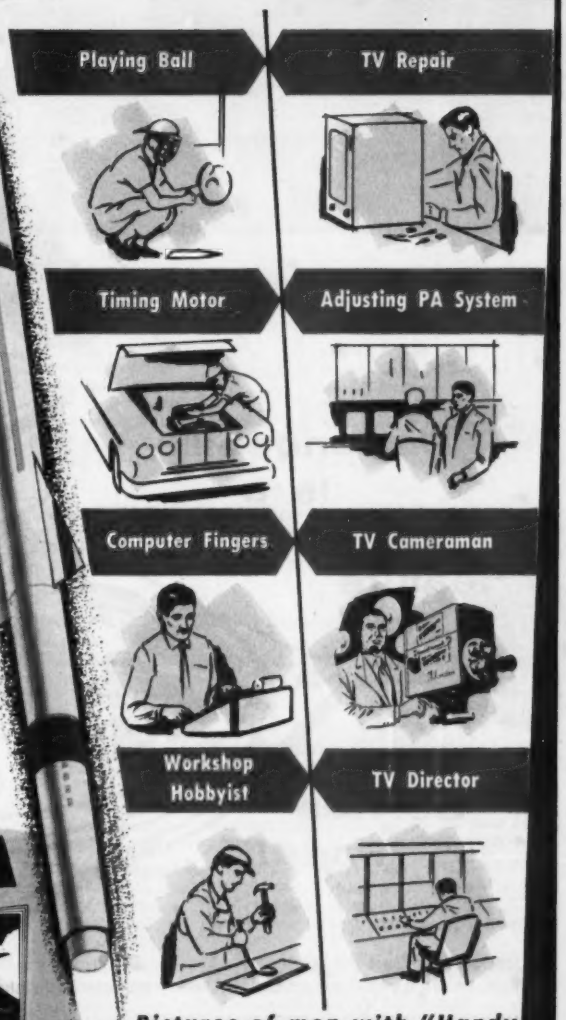

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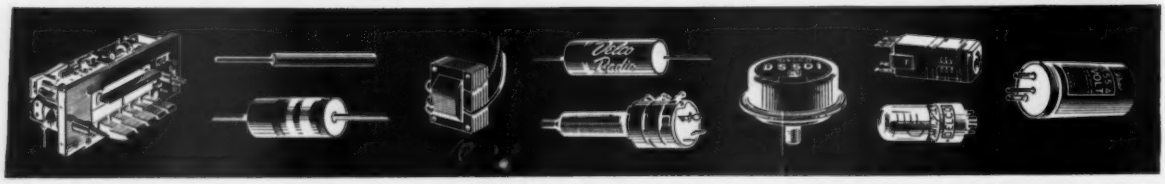

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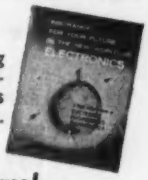

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By W. A. STOCKLIN
Editor

TRACKING THE "THOR"

WE were recently privileged to witness the actual launching of a "Thor" missile at the Vandenberg Air Force Base in California from the vantage point of a tracking van stationed three or four miles from the launching pad.

Granted that it would have been a lot more dramatic had we been closer than we were, still it was an unforgettable sight. The "Thor" is a single-stage missile which rises rather rapidly from the launching pad as compared to its predecessor, the "Redstone." The "Redstone" had a thrust only slightly in excess of its over-all weight and, when launched, it would seem to hover—making one wonder whether it would make it or not. The "Thor," on the other hand, has much more thrust and its launching is more decisive in that it leaves with a roar and accelerates rapidly. It leaves one with the feeling that it "knows where it's going."

From our vantage point, we saw the "Thor" rise from behind a hill and, in a matter of seconds, it was in a cloud bank lost to sight. Our interest then turned quickly to the tracking equipment and, of course, the results. The tracking van, one of several tracking centers stationed around the area, was a rather modest affair. It seemed to be limited only to recording essential information. It was capable of picking up several different characteristics telemetered by the missiles and these were confined solely to the operation of the power plant and navigational data.

The firing was all over in minutes and our attention turned to a chart approximately 20 feet in length which presented, graphically, seven channels of data. The complete results, of course, are not for publication, but we can reveal that the missile covered a distance in excess of 1000 miles and landed in a pre-designated area in the Pacific Ocean.

We were interested to learn that the only pertinent information recorded spanned the period from the firing of the missile to the moment that the motor cut off. The most critical factor for maximum target accuracy is the shut-off time of the motor. This must be done within a fraction of a second and from that point on, since this particular missile is not guided, its trajectory can be mathematically calculated, with a high degree of accuracy.

Vandenberg Air Force Base is located approximately 135 miles north of Los Angeles. It is directly on the Pacific Coast and the base is confined to an area some 14 by 28 miles. There is no doubt that this base will become the largest missile launching center on this continent and that, eventually, it will exceed Cape Canaveral in both size and activity. Its operations are not concerned with the procurement of scientific data from outer space but with weapon testing exclusively.

The base, which is under the jurisdiction of the First Missile Division of the Strategic Air Command, has over $14,000,000 worth of communications gear, cables, and terminating equipment and over a million dollars worth of other electronic equipment. Within three years plans call for a three-fold increase in their communications network to a total value of between 45 and 50 million dollars. —30—

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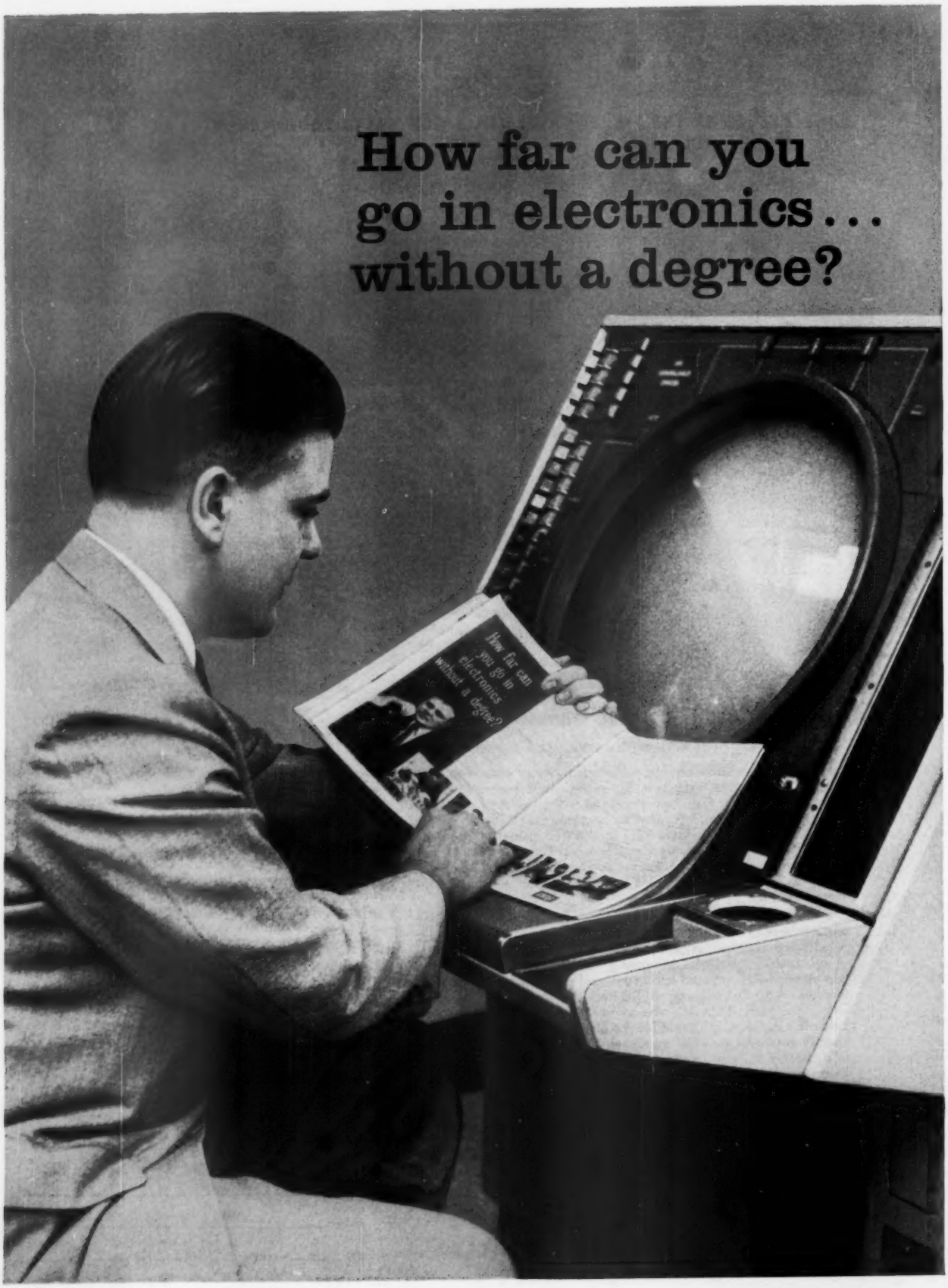
How far can you go in electronics... without a degree?
How far can you go in electronics without a degree?

At the SAGE display console, Dick Brani reads 1957 magazine story about his IBM career.

Dick Brani (right) discusses the new SAGE "memory" with a field engineer.

Two years ago, when Richard F. Brani was first asked to review his field engineering progress at IBM, he'd been recently promoted to computer instructor. Now, he has a new and more crucial responsibility: Group Manager of 20 field engineers who keep a SAGE computer operating at its peak, bulwarking America's air defenses. Here's his story.

GIVEN IMPORTANT ASSIGNMENT. "In my first four years with IBM, my field engineering career has taken several giant steps forward—despite my lack of a college degree," reports Dick Brani. "When I joined the Company, my special training consisted of graduation from a technical school, an F.C.C. license, and some Army engineering training. Now, I have a responsible management job in the SAGE Project, my knowledge of electronics has grown tremendously, and my future looks as promising as I could wish it.

"How did I make this progress? IBM believes that—after comprehensive training—technicians like me can handle assignments generally performed by graduate engineers. And IBM has been proved right. Hundreds of technicians are now functioning successfully as IBM field engineers."

20 WEEKS' COMPUTER TRAINING. Dick Brani joined IBM in the fall of 1955. He was immediately enrolled in a 20 weeks' computer units training program. "You learn how the different units of large-scale computers like SAGE operate . . . how the computer itself can help diagnose and locate trouble . . . and how to make fast, precise repairs," he says. "Once assigned to a SAGE Site, field engineers may also attend classes—during regular working hours, by the way—to keep up with advanced developments in electronics. Our site, for example, recently had a course on the new, increased-capacity SAGE 'memory'."

ADVANCES RAPIDLY IN FOUR YEARS. "I know of few other companies that offer technicians better or more valuable training than IBM," Dick Brani says. "This training can prove an 'open sesame' to engineering and management opportunities not usually available to men lacking college degrees."

After his training, Dick Brani's abilities won him a position as instructor in IBM's education program. For two years, he taught courses in computer units and systems. Then, a little over a year ago, he was promoted to Group Manager of 20 field engineers assigned to install—and maintain—a SAGE computer at a new site. "I'm responsible for the successful operation of the computer. I have to check out repairs my men do, schedule maintenance activities and supervise all new engineering changes."

Introducing a new field engineer to SAGE operations.

WHAT IS SAGE? SAGE is a vital part of America's air defense system. At the core of the SAGE system is a network of fast, extremely reliable electronic computers. In each sector of our nation, a SAGE computer is constantly in operation, 24 hours a day, helping the Air Force prevent surprise aerial attacks. Here's how SAGE works: The computer receives radar data from many observation points. It checks this information against known air traffic for the sector and presents to the Air Force a pictorial display of the air situation. If need be, the computer can guide a BOMARC missile to a target for certain interception.

COUNSELING TO DEVELOP STRONG LEADERS. "My most challenging duty as a SAGE Group Manager? Helping the men in my group advance and develop," replies Dick Brani. "One way I do this is by periodically rotating my men so that they become familiar with all phases of large-scale computer operation. But the most effective way is through counseling—just sitting down with a man and discussing his progress, his prospects, his career goals. IBM encourages frequent and intensive counseling. By this method the Company finds and develops the strong leaders it needs to stay at the head of its field."

SAGE PROGRAM STILL GROWING. "My future? I can advance to still more important responsibilities in SAGE field engineering," says Dick Brani. "SAGE has grown tremendously since its inception a few years ago, and it's still growing rapidly. Or, I can move into major spots in education, personnel, management, development engineering—or nearly any activity you can name. My future at IBM is limited only by my ability as an individual."

* * *

If you have a minimum of 3 years' technical schooling after high school—or equivalent experience—you may be eligible for 20 weeks' training as a computer units field engineer. While training, you receive full pay plus living allowance. Your starting salary will be determined by the extent of your education and experience.

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Within the Industry

DR. ROBERT J. GNAEDINGER, JR. has been named to the post of Senior Solid State Chemist for the Semiconductor Products Division of *Motorola Inc.*

He joins the New Processes Research Group and will be involved in the development of new chemical processing techniques, particularly as applied to the improvement of semiconductor device surface stability.

Dr. Gnaedinger received his doctorate in physical chemistry from the University of Chicago in 1951 and for the past five years has been a member of the technical staff of *Bell Telephone Laboratories*. Prior to that he was a post-doctoral research associate in the Department of Physics at the University of Illinois where he conducted binary metal alloy studies.

* * *

WALLY SHULAN of *Wally Shulan & Co.*, Jersey City, New Jersey has been elected president of the Electronic Representatives Association for 1960. He succeeds Burt C. Porter of Seattle, Washington in the post.

Charles N. Hoemig of *Hoemig Sales Co.*, Fort Wayne, Ind, was named chairman of the board while Philip Andress of Philadelphia, Clark R. Gibb of Minneapolis, and Robert Boniface of North Hollywood, California were named district vice-presidents for the eastern, central, and western districts respectively.

A former vice-president, Norman Kathrinus of St. Louis, was elected secretary while Harry Halinton of Chicago was re-elected to the post of treasurer. Announcement of the election results was made at the organization's first annual convention held in Chicago.

* * *

ARTHUR J. HATCH, JR. of New York City has been appointed a vice-president of *Stromberg-Carlson* and named general manager of its Special Products Division. In his new post Mr. Hatch succeeds Anthony G. Schifino, who resigned to become executive vice-president of *Rochester Radio Supply Company*.

As general manager of the Division, Mr. Hatch will direct the production and marketing of the firm's line of high-fidelity components and stereophonic "Component Ensembles," intercommunication and sound distribution systems, "Dial-X" private telephone systems, "Pagemaster" radio paging systems, auto radios, and a variety of other products.

He will make his headquarters in Rochester, New York.

* * *

CGS LABORATORIES, INC. of Wilton, Conn. has formed a new Magnetic Components Division under the management of John L. Gray . . . **ELECTRO-MEASUREMENT, INC.** of Portland, Oregon has changed its corporate name to **ELECTRO SCIENTIFIC INDUSTRIES.** No change in ownership or corporate structure is involved . . . **SONY CORPORATION** of Tokyo has set up its own United States distribution firm, **SONY CORPORATION OF AMERICA,** with offices at 514 Broadway, New York 12, N. Y. The new organization will handle the sales, repairs, and servicing of all of the firm's products heretofore distributed by **DELMONICO INTERNATIONAL.**

* * *

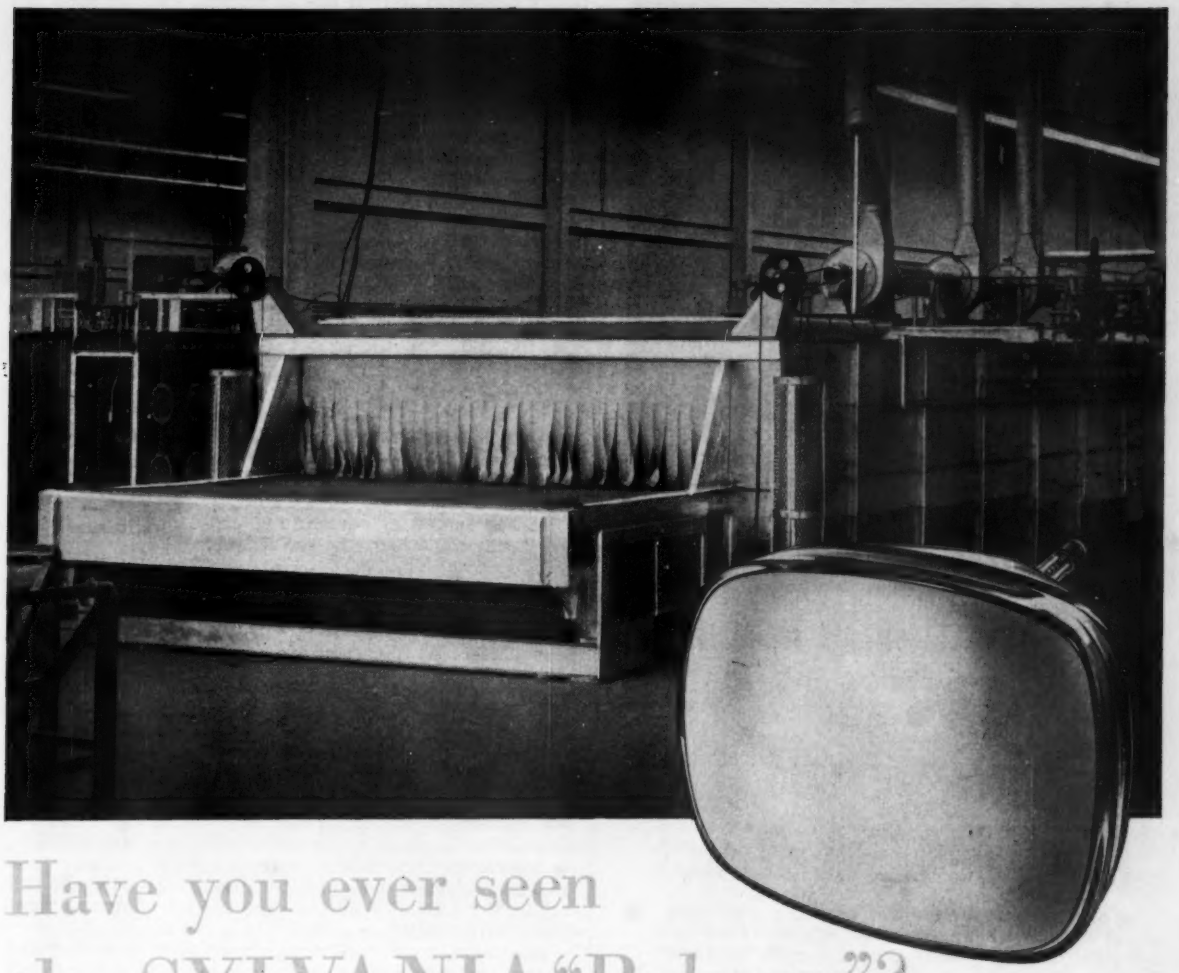
DR. HARVEY FLETCHER has been named consultant for *Shure Brothers, Inc.*, manufacturer of microphones, phono cartridges, and electronic components.

Dr. Fletcher is dean emeritus of the College of Physical and Engineering Sciences at Brigham Young University. From 1916 to 1949 he was with *Bell Telephone Laboratories*, retiring as director of physical research.

He is one of the organizers and a past president of both the Acoustical Society of America and the American Institute of Physics. He is also a Fellow and past president of the American Physical Society, a Fellow and past vice-president of the American Association for the Advancement of Science, and a Fellow of the AIEE.

* * *

TRANSCO PRODUCTS, INC. has completed a new building and special facilities at its West Los Angeles plant to provide a total of 22,000 square feet of floor space plus 10,000 square feet of external facilities for mock-ups and testing on a two-acre site . . . The new address for **TELEMETER MAGNETICS** is P.O. Box 329, Culver City, California . . . **TERMINAL ELECTRONICS, INC.** has moved into a modernized, air-conditioned, three-story building at 236 W. 17th Street in New York City . . . The Parts Division of **SYLVANIA ELECTRIC PRODUCTS INC.** will construct an 18,000-square-foot weld plant on the com-



Have you ever seen the SYLVANIA "Bakery"?

"Bakery"? An "Oven"? Yes, but not for bread. For Silver Screen 85 Picture Tubes! Giant ovens (Lehrs)—each about one-third the length of a football field—"bake in" the big differences that make Sylvania Silver Screen 85 the finest replacement TV picture tube... *second to none!*

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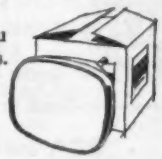
This treatment must be done slowly, under careful controls and is very essential to the proper processing of the bulb. This process also assures "stronger" glass, free of undesired strains. It extends picture tube life by ridding the bulb of contaminants that could later cause inter-element leakage, gassing and loss of emission. The manufacturer who employs expensive equipment such as this can assure you of a consistently top-quality product.

So, when you recommend a replacement picture tube, recommend the finest... a Sylvania Silver Screen 85. It gives your customers what they want: better pictures for a longer time. Gives you what you need: profitable TV service calls.



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pany's Lexington Avenue site in Warren, Pa. The plant is expected to be in operation by September . . . **CBS ELECTRONICS** has opened a new warehouse at 231 Johnson Ave. in Newark, N. J. . . . **ZENITH RADIO RESEARCH CORPORATION** has moved to a new plant at Menlo Park, California . . . **SOUND APPARATUS COMPANY** has moved from Stirling, New Jersey to new quarters in Tucson, Arizona. The mailing address is P.O. Box 1471 . . . **BEL CANTO STEREOPHONIC RECORDINGS** has moved its Culver City based headquarters to Columbus, Ohio. The firm is a subsidiary of **THOMPSON - RAMO - WOOLDRIDGE . . . OLSON RADIO CORPORATION** of Akron, Ohio has announced the opening of its eighth warehouse and store at 4642 W. Century Blvd., Los Angeles . . . The audio products section of **GENERAL ELECTRIC COMPANY's** radio receiver department is being transferred to existing company-owned facilities in Decatur, Illinois . . . **LAND-C-AIR SALES,** manufacturers' representative, has moved its main office to 76 Main Street in Tuckahoe, New York.

* * *

SAMUEL J. McDONALD has been appointed assistant manager of the distributor sales department of *Sylvania Electronic Tubes,* a division of *Sylvania Electric Products Inc.*

He has served as eastern regional distributor sales manager for the division since 1956 and prior to that was northeastern district manager at the company's Woburn, Mass. office. In his new post he will continue to have his headquarters at the company's sales office in New York City.

Mr. McDonald joined the company in 1943 as supervisor of personnel in Salem, Mass. and joined the distributor sales department in 1946. He is a graduate of Brown University and also attended MIT, Boston University, and Harvard.

* * *

EIA has issued production figures covering radio and TV sets as well as phonographs and TV and receiving tubes.

According to the industry's trade association more than 15.6 million radios were made in 1959 as against about 12.5 million for 1958. TV output exceeded 6.3 million as compared with 4.9 million in 1958.

More than 2.7 million stereophonic units were included in the total of nearly 4.4 million phonographs sold at retail last year while factories sold more than 4.3 million phonographs, some 3 million of them stereo. The figures on phonograph sales are for complete packages only and do not include the component field. During 1958 approximately 2,867,606 mono phonographs were sold at the factory level while 1,104,924 stereo units were shipped.

TV picture tube production for 1959 totaled 9,522,546 units as against 8,252,480 for 1958 while receiving tubes reached almost 433 million as against some 397 million for the previous year.

* * *

AUDIO DEVICES, INC. has approved the sale of the firm's rectifier division in Santa Ana, California to the **LARK CORPORATION** by an overwhelming vote of its stockholders . . . **BENDIX AVIATION CORPORATION** stockholders voted to adopt a new name, **THE BENDIX CORPORATION,** as indicative of the company's diversified industrial position. The new name will be put into effect about June 1st of this year . . . **REEVES SOUNDCRAFT CORPORATION** has purchased the blank recording disc manufacturing facilities and inventories of the **BOGEN-PRESTO DIVISION** of **SIEGLER CORP.** . . . **TEXTRON INC.** has acquired **TERRY MACHINERY COMPANY LTD.** of Montreal, Canada for an undisclosed cash purchase price. The new subsidiary will continue under the management of W. H. Terry, founder of the company . . . **TELETEX, INC.** of St. Paul, Minn. has announced the acquisition of all assets and business of **BALLASTRAN CORPORATION,** Fort Wayne, Ind. manufacturer of magnetic-type devices for the electronics industry . . . **ELECTRONIC ENGINEERING COMPANY OF CALIFORNIA** has purchased the **ANAHEIM ELECTRONICS COMPANY, INC.,** maker of electronic program control devices. —30—

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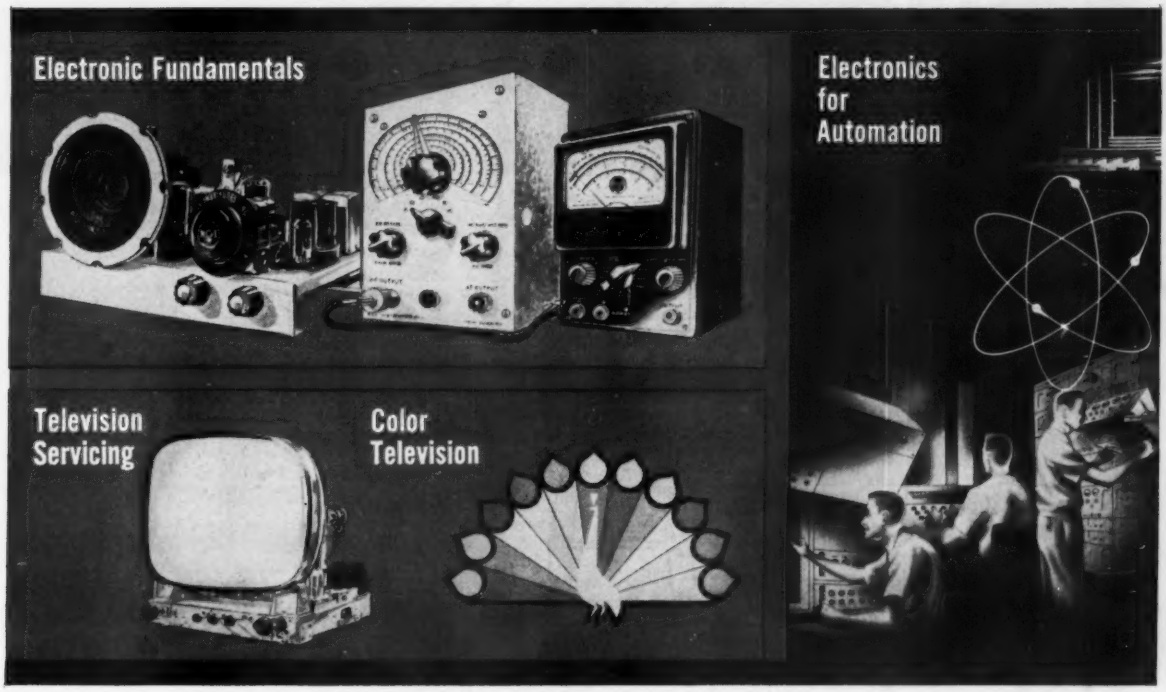

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The CBS 6CG7 is a premium-performance tube. Hum-free coil heaters assure long life. And combined with a ring getter and pinched cathodes, they virtually eliminate heater-cathode leakage . . . notorious for causing loss of horizontal sync. Twin top micas and semi-automated precision assembly minimize microphonism. Truly the CBS 6CG7 . . . best in the industry . . . has advance-engineered features found only in premium-performance tubes.

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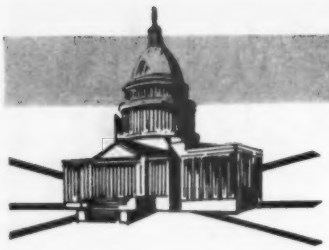

Spot News

Latest Information on the Electronic Industry

By ELECTRONICS WORLD'S WASHINGTON EDITOR

HAM LICENSES UP OVER 285 PER-CENT IN 12 YEARS—Over 200,000 persons now hold amateur operating licenses, while the number of outstanding station licenses is approaching 204,500—so revealed the FCC recently. This growth represents a gain of more than 285 per-cent since the resumption of ham radio after World War II. Almost without exception, Washington noted, every ham operator has a station license; the extra number of station licenses were said to be held by amateur clubs and by those who have stations at more than one fixed address.

BIG GAIN IN OVERSEAS TV—Television abroad is booming, according to the U.S. Information Agency. There are now over 1000 transmitters and more than 32,000,000 TV receivers in operation overseas. During the past year, 282 new transmitting stations went on the air in the Free World and 67 new stations were inaugurated in Sino-Soviet countries. Of the new stations placed on the air, 211 are in Western Europe, 46 in the Far East, 19 in Latin America, 6 in the Near East, South Asia, and Africa areas. Western Europe has 19,000,000 TV sets; the Far East more than 5,000,000; Latin America about 2,500,000; and the Near East, South Asia, and Africa somewhat less than 100,000. The United Kingdom, with 10,000,000 receivers, leads the Free World followed by Japan, Western Germany, Italy, and France. The Soviet Union reportedly has 4,000,000 sets in use and East Germany and Czechoslovakia about 500,000 each.

ARMY ELECTRONIC WEATHER FORECASTING SYSTEM UNDER TEST—A rapid weather-observing system, developed by the Army Signal Corps, to locate instantly lightning discharges associated with severe storms over most of North America, is now undergoing tests at Kansas City, Mo. A network of six stations has been equipped with special radio receivers to pick up static generated by lightning. Each station picks up the danger signals almost simultaneously, registers time and compass direction, and relays the information to a central monitor. An electronic device serves to plot and display, within a tenth of a second on a special electronic map of North America, the position of the lightning. Capable of detecting lightning up to 2000 miles and tracking a storm's position, the automatic network, when it becomes operational, will provide data jointly to the USAF Severe Weather Warning Center and to the U.S. Weather Bureau's severe local storm units to warn forecasters of severe weather; it will also be used for military weather research. Future applications of the system could also give weathermen a better look at severe weather conditions far out to sea, where there are sparse weather reporting stations. Such warnings could help forecasters make more reliable long-range predictions and aid in routing transoceanic planes and ships around storms.

SOME 200 SYLVANIA AND RCA ENGINEERS TAKE BMEWS TRAINING—Approximately 200 engineers and technicians of Sylvania Electric Products Inc. and Radio Corporation of America are undergoing intensive training, ranging from computer circuitry to survival in sub-zero arctic storms—for installation, maintenance, and operation of the data processing phase of the Air Force's Ballistic Missile Early Warning System (BMEWS). The classroom and laboratory work is being conducted in the Training Center of the Data Systems Operations of Sylvania at West Roxbury, Mass. Training courses will cover a three-year period and draw on members of the Sylvania field engineering organization and representatives of RCA Service Co. who will operate and maintain the equipment after installation. A total of 17 individual BMEWS classes are being conducted, extending in length from one week to 11 months. Since the training is conducted on a 40-hour-a-week basis, the 11-month course is the equivalent of more than two years of normal college study.

ACCURACY OF NBS ATOMIC CLOCK—The Boulder Laboratories of the National Bureau of Standards has announced the development of a new atomic clock which will be accurate within one second in one thousand years. The new clock measures both time and frequencies by the "ticks" of cesium atoms and is believed by NBS to be the most accurate such instrument in the world—ten times more accurate than any previous NBS atomic clock. It was developed by the NBS Atomic Frequency and Time Standards Section under Dr. Richard C. Mockler, at the Boulder Laboratories in Boulder, Colorado.

-30-

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Harold W. Johnson, 5070 Hermosa Ave., Los Angeles, Calif.	1st	15
Arthur W. Hardy, 66 Dresser Ave., Great Barrington, Mass.	1st	12
Ralph Frederick Beisner, 2126 Grand, Joplin, Mo.	1st	12
N. B. Mills, II, 110 So. Race St., Statesville, N.C.	1st	12
Dean A. Darling, 403 S. Chase Ave., Columbus 4, Ohio	1st	12

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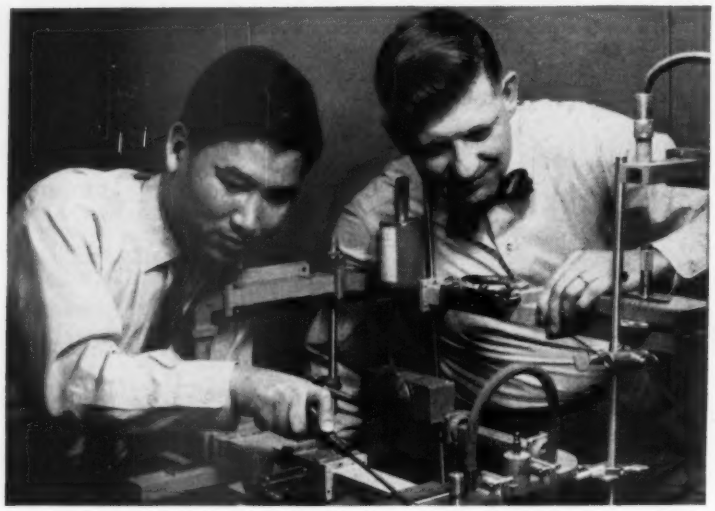
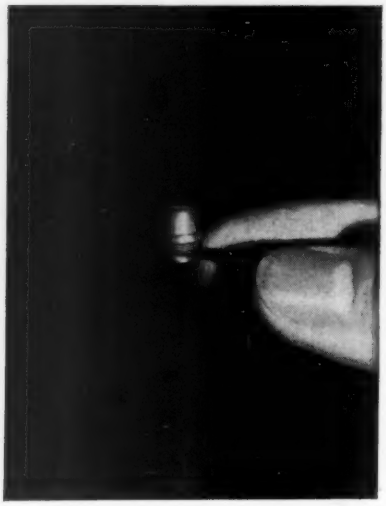


At Bell Laboratories, M. Uenohara (left) adjusts his reactance amplifier, assisted by A. E. Bakanowski, who helped develop first suitable diode. Extremely low "noise" is achieved when certain diodes are cooled in liquid nitrogen.

First practical diode for amplifier, shown here held by tweezers, was jointly developed by A. E. Bakanowski and A. Uhlir.



How basic scientific ideas develop in the light of expanding knowledge is strikingly illustrated by the development of Bell Laboratories' new "parametric" or "reactance" amplifier.

Over 100 years ago, scientists experimenting with vibrating strings observed that vibrations could be amplified by giving them a push at strategic moments, using properly synchronized tuning forks. This is done in much the same way a child on a swing "pumps" in new energy by shifting his center of gravity in step with his motion.

At the turn of the century, scientists theorized that *electrical* vibrations, too, could be amplified by synchronously varying the *reactance* of an inductor or capacitor. Later amplifiers were made to work on this principle but none at microwave frequencies.

Then came the middle 50's. Bell Telephone Laboratories scientists, by applying their new transistor technology, developed semiconductor diodes of greatly improved capabilities. They determined theoretically *how* the electrical capacitance of these new diodes could be utilized to amplify at *microwave* frequencies. They created a new microwave amplifier with far less "noise" than conventional amplifiers.

The new reactance amplifier has a busy future in the battle with "noise." At present, it is being developed for applications in tropospheric transmission and radar. But it has many other possible applications, as well. It can be used, for instance, in the reception of signals reflected from satellites. It is still another example of the continuing efforts to improve your Bell System communications.

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CHARLES C. ROBERSON
Cheyenne, Wyoming

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Herbert W. Clay, Phoenix, Arizona	2nd	22 weeks
Thomas J. Bingham, Finley, North Dakota	2nd	9 weeks
William F. Masterson, Key West, Fla.	2nd	24 weeks

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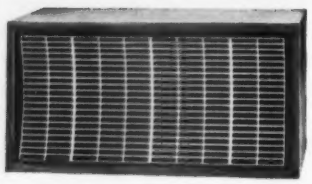

Among many individuals, there is a need to minimize on the space to be devoted to a component stereo system. A rash of "bookshelf" types have appeared in an attempt to meet this need. In practice, however, they seem neither fish nor fowl,...either too large for compactly spaced bookshelves or too small for use as free-standing units.

The AUDAX CA-60 is a *true* bookshelf speaker system, measuring only 9" high by 10½" deep by 18" wide. It houses a 6" woofer and separate tweeter in a ducted-slot enclosure constructed of ¾" thick wood, finished in oiled, hand-rubbed walnut on four sides. The grille is shaped in an attractive parabolic contour, giving the unit a character which blends with a variety of surroundings.

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NEW AMPLIFIER STANDARDS

To the Editors:

This is in reference to the article "New Hi-Fi Amplifier Standard" that appeared in your January, 1960 issue.

It appears to me that the procedure outlined in the new IHFM Standard for measuring damping factor is inadequate and will produce non-uniform results at the rather low internal resistances found in many of the finer units. Not only will the connecting and internal leads used to connect the calibrating resistance upset the accuracy of the reading at very low resistance values, but how can an infinite reading or, for that matter, a negative reading, be made with the procedure as described?

A much less awkward, and certainly a more adaptable, system can be used which will produce a better degree of accuracy with less critical demand on the associated testing equipment. It is only necessary to put a dummy load across the prescribed terminals (an 8-ohm resistance across the 8-ohm terminals) and adjust for an output of one volt using an ordinary voltmeter; the load is then removed and the new voltage noted. The damping factor is the reciprocal of the change in voltage.

For example, if the voltage rises to 1.2 volts when open circuited (a change of .2 volt), the DF is 1/.2 or 5. If there is no change when the load is removed, the DF is 1/0 or infinite. If the voltage drops to .8 (a change of −.2 volt), the DF is 1/−.2 or −5. The formula to employ for any output voltage used is $DF = E_l/E_o - E_l$, where E_l is the output voltage under load and E_o is the output voltage into an open circuit.

ELBERT E. JENKINS, JR.
Macon, Georgia

* * *

AIR TRAFFIC CONTROL

To the Editors:

Let me congratulate you on your article "Air Traffic Control by Electronics" by James A. Niland. This article appeared in the January, 1960 issue and gives a much needed boost to the controllers who are doing an extremely fine job of air traffic control.

The paragraph under the heading "Scan Converters" contains the following statement. "Although on order from *Intercontinental Electronics Corporation* since 1958, production and installation delayed the commissioning of the scan converters until a few months ago." This statement is not accurate. Therefore, in the interest of accuracy, I feel obliged to call to your attention the fact that over a three-year period of doing business with the FAA, *Intercontinental Electronics* has never been late on delivery.

As far as *INTEC's* deliveries of these systems are concerned, the record is the following: The first contract with *INTEC* was signed on September 22, 1958 and called for delivery of one system within 100 calendar days; the contract also called for an additional system to be delivered within 135 calendar days and for the balance of the systems to be shipped one every 30 calendar days thereafter. Indeed, we delivered in accordance with the terms of this contract. The first shipment was made on December 23, 1958; it concerned the systems delivered to the New York Air Route Traffic Control Center. We proceeded from this first installation to produce and deliver the succeeding installations within the time schedule cited in the contract.

At present, all of the systems originally ordered have been delivered and most of them are in operation at the various FAA Air Route Traffic Control Centers, and as a result of our excellent delivery record, our contract has now been extended substantially.

LEONARD GOLDMAN
Director of Marketing
Intercontinental Electronics Corp.
Mineola, New York

It was not our intention to create any wrong impression concerning Intercontinental Electronics. *We hope the above will set the record right.—Editors.*

* * *

TRANSISTORIZED "FISH FINDER"

To the Editors:

Several of us have decided to build the "Transistorized 'Fish Finder' " that appeared in your August, 1959 issue. We were not able to locate the pulse transformer (T_1) specified, although we did manage to get some of the alternate *UTC* H51 transformers. However, with these transformers installed in the circuit, we could not get the unit to operate properly.

We hope you will be able to assist us in some way since we are very anxious to get the unit going before summer.

ROBERT BRYAN
Chicago, Illinois

Our parts listing for transformer T_1 should have been for type 331:3 and not 331:1 as shown. The original transformer was a product of PCA Electronics, Inc. *The complete address of the company is 16799 Schoenborn St., Sepulveda, California. The transformer is also available from* Polyphase Instrument Co., *East 4th St., Bridgeport, Pennsylvania.*

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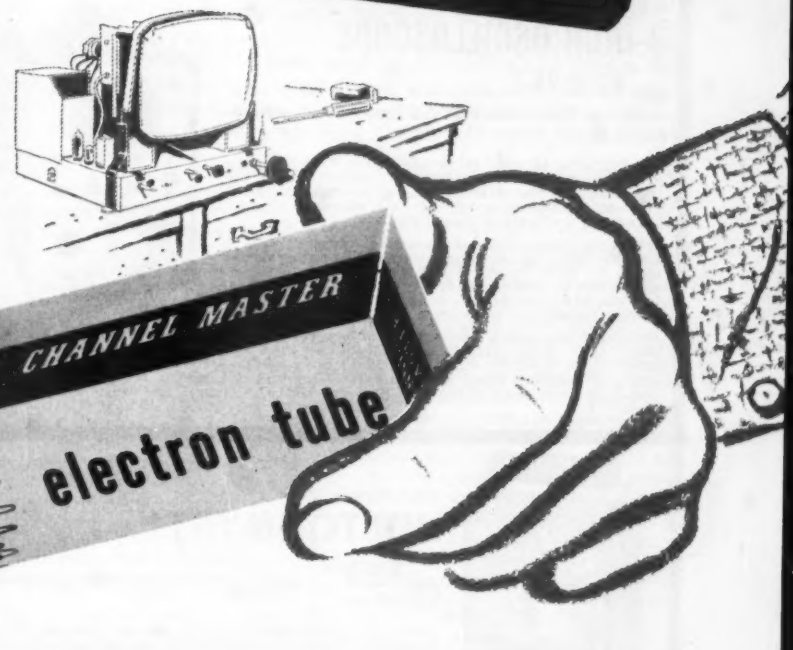

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Exclusive features make this RCA VOM kit the buy of a lifetime! Extra 1-volt and 0.25 volt (250 mv) ranges for wider usage in transistor servicing—new handle clip accommodates probes and test leads for extra carrying convenience. Assembles in a breeze!

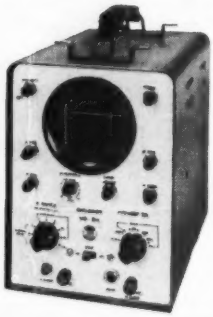
FEATURING: ohms-divider network fuse-protected • easier-to-read scales • extra-large 5¼ inch meter • polarity reversal switch • excellent frequency response • full-wave bridge rectifier • low circuit loading • standard dbm ranges.

SPECIFICATIONS: Input Resistance—20,000 ohms per volt on DC; 5,000 ohms per volt on AC • Accuracy—± 3% DC, ± 5% AC (full scale) • Regular Scales—2.5, 10, 50, 250, 1000, 5000 volts, AC and DC; 50 μa 1, 10, 100, 500 ma, 10 amps (DC) • Extra Scales—250 mv. and 1 volt (dc) • Frequency Response—AC-flat from 10 cycles to 50 Kc (usable response at 500 Kc) • Ohms—3 ranges: Rx1—(0-2,000 ohms); Rx100 (0-200,000 ohms); Rx10,000 (0-20,000,000 ohms) • Dimensions—W. 5¼", H. 6⅞", D. 3⅛"

RCA WO-33A (K)

3-INCH OSCILLOSCOPE

only **$79.95*** *(complete with Low-Cap, Direct Input Probe and Cable) (also available factory-wired and calibrated—only $129.95*)*



The first 'scope kit with "get-up-and-go!" Use it for practically everything—video servicing, audio and ultrasonic equipment, low level audio servicing of pickups, mikes, pre-amps, radios and amplifiers, troubleshooting ham radio, hi-fi equipment, etc.—and you can take it with you, on the job, anywhere!

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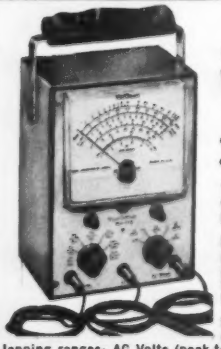
SPECIFICATIONS: Vertical Amplifier (Narrow Band Position)—Sensitivity, 3 rms mv/inch; Bandwidth, within —3 db, 20 cps to 150 Kc • Vertical Amplifier (Wide Band Position)—Sensitivity, 100 rms mv/inch; Bandwidth, within —3db, 5.5 cps to 5.5 Mc • Vertical Input Impedance—At Low-Cap cable input...10 megohms, 10 μμf (approx.); At Direct-cable input...1 megohm, 90 μμf (approx.) • Sweep Circuit—Sawtooth Range, 15 cps to 75 Kc; Sync, external, ± internal; Line Sweep, 160° adjustable phase.



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FEATURING: ohms-divider network protected by fuse • ultra-slim probes and flexible leads • sleeve attachment on handle stores probes, leads, power cord • separate 1½ volts rms and 4 volts peak-to-peak scales for accuracy on-low ac measurements • front-panel lettering acid-etched.

SPECIFICATIONS: Measures: DC Volts—0.02 volt to 1500 volts in 7 overlapping ranges; AC Volts (RMS)—0.1 volt to 1500 volts in 7 overlapping ranges; AC Volts (peak-to-peak)—0.2 volt to 4000 volts in 7 overlapping ranges; Resistance—from 0.2 ohm to 1000 megohms in 7 overlapping ranges. Zero-center indication for discriminator alignment • Accuracy—± 3% of full scale on dc ranges; ± 5% of full scale on ac ranges • Frequency Response—flat within ± 5%, from 40 cycles to 5 Mc on the 1.5, 5, and 15-volt rms ranges and the 4, 14, and 40-volt peak-to-peak ranges • DC Input Resistance—standard 11 megohms (1 megohm resistor in probe).

*User Price (Optional)

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ELECTRON TUBE DIVISION HARRISON, N. J.

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Several of the units have been built successfully using the UTC *H51 transformer specified as an alternate. With this transformer, the pulse width is somewhat narrower than with the original transformer. Therefore, our readers will have to experiment with the values of* C_{11}, R_{11} *and* R_{12} *in order to get the circuit to operate as it should. The same numbered terminals are used for the* UTC *transformer as for the* PCA *unit.—Editors.*

* * *

OSCILLATION IN CB TRANSCEIVERS

To the Editors:

I have had repeated trouble with what I had thought was the microphone in my Citizens Band transceiver. The complaint was a low-frequency howl that appeared between periods of modulation. If you have listened to the Citizens Band during the past few months, I am sure that you have heard many transceivers that emit this peculiar howl, and you may have wondered what caused it.

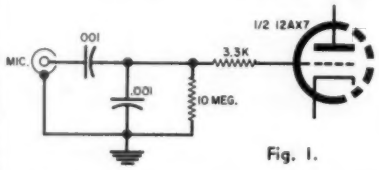

Fig. 1.

I returned the mike to *Shure Bros.*, and they found it to be in perfect condition, but suggested that the howling might be caused by r.f. feedback. They suggested the circuit shown in Fig. 1 for inclusion in my transceiver. I've installed it and it works. I have also passed it along to a number of people on the Citizens Band and each of them reports that it is successful.

W. H. C.
Linthicum Heights,
Maryland

The above suggestions are good ones. We have also suggested to our readers who have had this same problem the simple addition of a 330-μμf. capacitor directly across the microphone.—Editors.

* * *

WIRE FUSES

To the Editors:

I have noticed that a good many of the later model TV sets make use of a short length (1 or 2 inches) of #24 or #26 wire in the filament string in place of a fuse.

I wonder if you could tell me if there is any literature available describing how to put this to good economical use; *i.e.*, what gauge of wire, the length, and the current carrying capacity.

PAUL HOLLIDAY
Long Island City, New York

There are indeed tables in some of the engineering handbooks giving the current-carrying capacity of wire of various gauges so that such wire may be used as a fuse. Also, such a table appears in "The Radio Amateur's Handbook" published by the ARRL.—Editors. -30-

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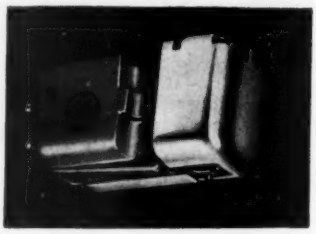
Stop to think for a moment of all the jobs required of a stereo cartridge: It must track, with utmost precision, in not one but two directions. It must separate the two stereo channels inscribed in a single record groove. It must perform smoothly in mid-range and at both ends of the audible frequency spectrum. And it must do all these things without producing noticeable hum or noise. Only a fantastically sensitive and precise instrument like the General Electric VR-22 can do all these jobs successfully.

General Electric's VR-22 is superior in the four vital areas of stereo cartridge performance: (1) **Compliance**—It tracks precisely, without the least trace of stiffness. (2) **Channel separation**—Up to 28 db for maximum stereo effect. (3) **Response**—Smooth and flat for superior sound from 20 to 20,000 cycles (VR-22-5), 20 to 17,000 cycles (VR-22-7). (4) **Freedom from hum**—The VR-22 is triple-shielded against stray currents.



VR-22-5 with .5 mil diamond stylus for professional quality tone arms, **$27.95***. VR-22-7 with .7 mil diamond stylus for professional arms and record changers, **$24.95***. Both are excellent for monophonic records, too. TM-2G Tone Arm—designed for use with General Electric stereo cartridges as an integrated pickup system, **$29.95***.

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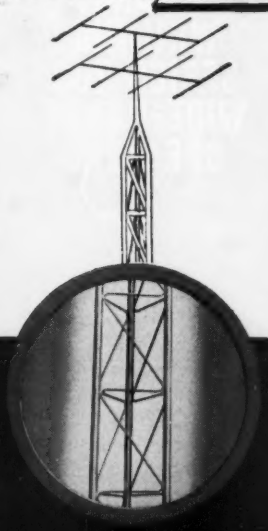
ROOF TOWERS
Installation Accessories



From every standpoint, ROHN Towers offer you MORE . . . more quality, more variety, more advanced design, more sales features, more service, more total sales and more PROFITS! Move forward with these ROHN items!

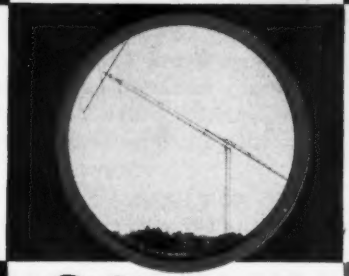
ROHN TV TOWERS

ROHN makes the finest towers available for television reception! Illustrated is the No. 25 with amazing "zig-zag" cross bracing design. The entire tower is rated 33% stronger than other similar sized towers. Yes, sell and install the No. 25 up to 50 feet self-supporting or, properly guyed, up to 360 feet!

Or if you prefer, sell the popular ROHN No. 6 tower with the famous "Magic Triangle" cross-bracing. Both are fully HOT DIPPED GALVANIZED AFTER FABRICATION! Sections in easy-to-handle 10 ft. lengths.

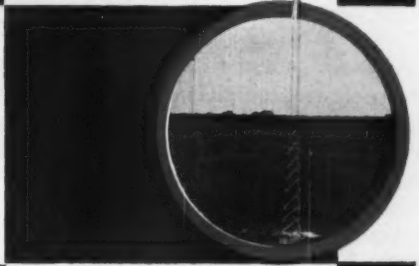
ROHN COMMUNICATION TOWERS

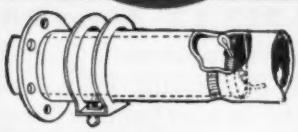
Here you have FIVE complete lines of heavy-duty, FULLY ENGINEERED communication towers to fulfill any communications requirement. Shown is the ROHN "55" tower which is self-supporting up to 130 feet. Other models — (30-40-50-60) are available in heights up to 630 feet when guyed! Handle these towers for the demand in your area. There's a complete NEW catalog on this line. Get a copy so you'll have it on hand.



AMATEUR "FOLD-OVER" TOWERS

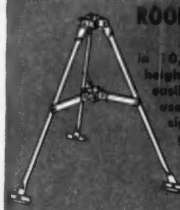
Specially designed "fold-over" towers are the best ever designed for amateur radio and experimentation. They are the most desired because they "fold-over" completely so you work on the ground for ease and safety. Three sizes, including heavy-duty type to handle any needs. All hot dipped galvanized.





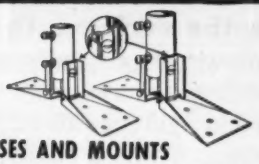
TELESCOPING MASTS

Unexcelled in design, structural strength, and sales appeal. All popular sizes, heights, and weights available. Also, mast tubing in exact specifications that's demanded today.



ROOF TOWERS . . .

in 10, 5, 3, and 2½ foot heights — very popular — easily shipped — ideal to use — the best ever designed — in hot-dipped galvanized finish — truly a big profit item for you!



BASES AND MOUNTS

Wide variety of bases and mounts. Special features include "locking" device — also cast aluminum roof mounts — and a host of other installation items . . . get full details.

TV SERVICE TABLE

For holding TV sets while servicing, or storing, or for mobile use of set in such places as motels, hospitals, etc. Ideal for dozens of uses — thousands sold. Large casters — a real work-saver.

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Manufacturing Company

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FOR FAITHFULNESS IN PERFORMANCE

NOTHING COMPARES WITH UNIVERSITY'S NEW AWARD WINNING SERIES 200 WIDE-RANGE SPEAKERS

Features of the Series 200 Model 312

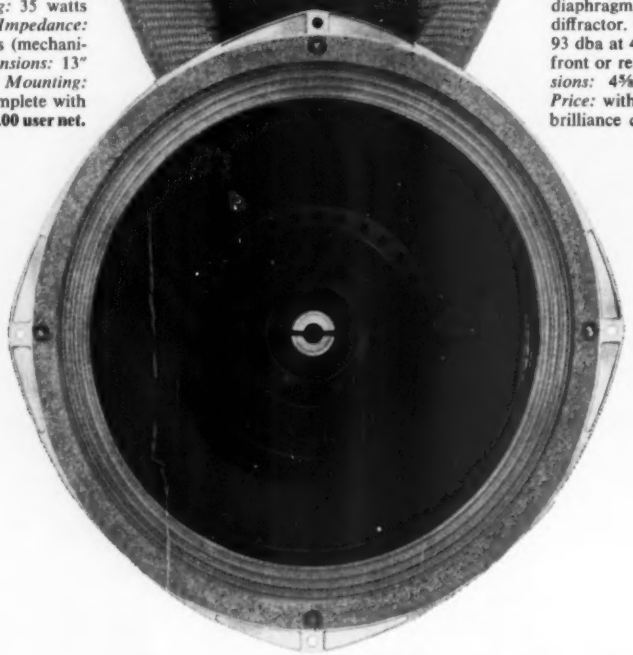
ONE-PIECE DIE-CAST BASKET provides perfect rigidity for the entire structure, assuring life-long stability and reliability. Further, its narrow struts offer a minimum of reflecting surfaces, thus avoiding unwanted peaks and valleys in the frequency response.

EXCEPTIONALLY RIGID WOOFER CONE with two highly compliant cloth suspensions—inner and outer—achieves the large, unhindered piston-like excursions necessary to reproduce the lowest bass frequencies.

MID-RANGE is provided by the patented Diffusicone, an auxiliary light cone driven by the main voice coil, and designed with a perforated surround that produces uniform dispersion of the frequencies in the 1000-3000 cps range.

THE SPHERICON SUPER TWEETER has its own specially constructed reflector baffle to prevent any acoustic interference from the reflections of the main cone . . . thus solving a problem generally associated with integrated speakers.

SPECIFICATIONS: *Frequency response:* 28 cps to 40,000 cps. *Power rating:* 35 watts integrated program material. *Impedance:* 8-16 ohms. *Crossovers:* 1000 cps (mechanical) 3000 cps (electrical). *Dimensions:* 13" over-all diameter, 6⅝" depth. *Mounting:* front or rear of baffle. *Price:* complete with adjustable brilliance control **$73.00 user net.**



Model T202 Sphericon Super Tweeter

Frequency response from 3000 cps to 40,000 cps, ±2 db to 22,000 cps!

The Sphericon is also available separately as the Model T202 for those who wish to add its thrilling and *complete* high frequency reproduction to their present systems.

The entirely new concept of this direct radiator tweeter, with its special domed phenolic diaphragm and spherical diffractor, results in a virtually linear response—with *true* musical quality—far superior to even the finest electrostatic tweeters.

And unlike the electrostatic tweeter, the efficient Sphericon can be perfectly matched to any system . . . especially high compliance . . . without sacrificing bass efficiency.

Compare the Sphericon with any other tweeter . . . at three or even four times its price . . . and hear everything you've been missing till now!

SPECIFICATIONS: *Dispersion:* 120° in all directions. *Power capacity:* 30 watts integrated program. *Impedance:* 8 ohms nominal (may be used with any 4-16 ohm speaker). *Design features:* domed phenolic diaphragm, conoidal ring loading, spherical diffractor. *Crossover:* 3000 cps. *Sensitivity:* 93 dba at 4 ft. with 1 watt input. *Mounting:* front or rear surface of baffleboard. *Dimensions:* 4⅝" diameter, 4" depth over-all. *Price:* with built-in network and adjustable brilliance control ..... **$24.95 user net.**

First in the series...the *new* award-winning* Model 312 12" 3-Way Diffaxial

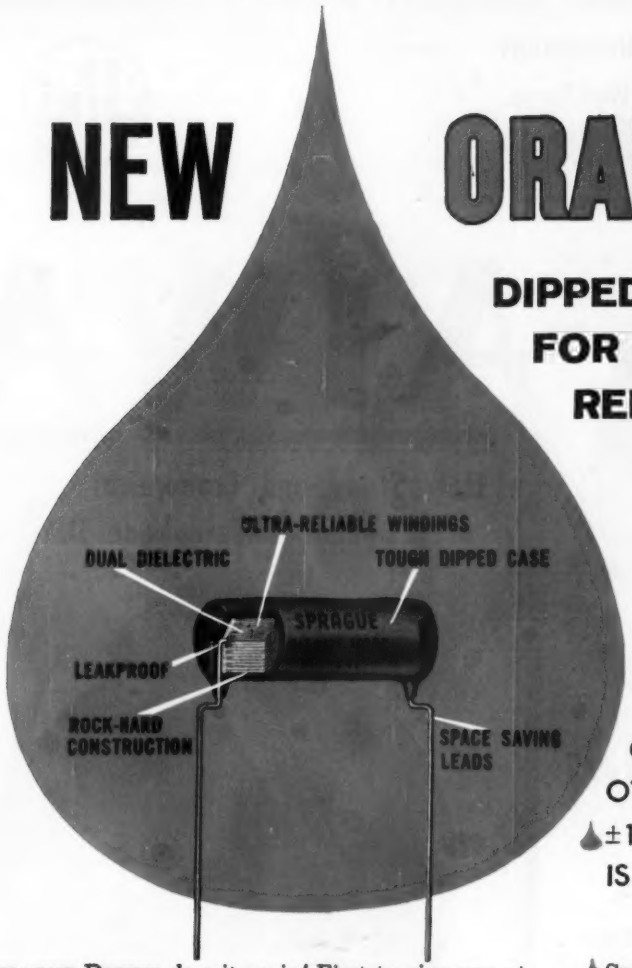
The award-winning basket frame of the 312 is only one of the many advanced acoustic design features that contribute to its extraordinarily clean and wide response range. Its specially damped cloth suspensions and rigid cone afford rich, deep bass response down to 28 cps. Its high frequency response to 40,000 cps . . . with a clarity, transparency and sweetness never thought possible . . . is provided by the fabulous new Sphericon Super Tweeter. The highly efficient Model 312 can attain distortion-free "concert" volume even when driven by modestly powered amplifiers, yet its rugged construction permits the use of high powered amplifiers with complete safety. For both perfectly integrated performance and convenience in installation, *the new University Model 312 is your ideal choice!*

*For design that "possesses all the rigidity and dimensional stability needed to assure permanent centering of the speaker cone, magnetic pot assembly and other components . . ." the radically new die-cast basket of the 312 was unanimously awarded first prize in industrial design competition that attracted entries from 18 major industries • UNIVERSITY LOUDSPEAKERS, INC., WHITE PLAINS, N. Y. *A subsidiary of Ling-Altec Electronics, Inc.*

University

NEW ORANGE-DROP®

DIPPED DIFILM® CAPACITORS FOR EXACT ORIGINAL REPLACEMENT



THIS NEW . . . MINIATURE . . . DIFILM CAPACITOR OUTPERFORMS ALL OTHER DIPPED TUBULAR CAPACITORS!

▲ ±10% CAPACITANCE TOLERANCE IS STANDARD.

SPRAGUE DIFILM *does it again!* First to give you at regular prices the finest molded tubular capacitor made—the DIFILM BLACK BEAUTY . . . and now the newest DIFILM capacitor—the ORANGE-DROP dipped capacitor.

▲SPRAGUE ORANGE-DROP CAPACITORS are especially made for easy installation in tight spots . . . where only an exact replacement will fit. They are the exact same dipped capacitors used by leading manufacturers in many TV sets.

WHY ORANGE-DROPS BEAT HEAT AND HUMIDITY

Sprague Orange-Drop Mylar*-Paper Dipped Capacitors combine the proven long life of paper capacitors with the effective moisture resistance of film capacitors. Their duplex dielectric of kraft paper and polyester film is impregnated with HCX®, Sprague's exclusive hydrocarbon material which saturates the paper and fills voids and pinholes in the film before the HCX polymerizes. The result is a solid, rock-hard capacitor section which is then double-dipped in bright orange epoxy resin for moisture protection. Leads are neatly crimped for easy installation on printed wiring boards.

▲SPRAGUE ORANGE-DROP CAPACITORS are a natural teammate for the molded Difilm Black Beauty®. Black Beauties, born out of engineering to tough missile standards, are still far and away the best replacement capacitors—better than any other molded or dipped . . . paper, film, or film-paper combination . . . capacitor made for entertainment electronics.

▲Where a dipped capacitor is called for, no other dipped unit can match the ORANGE-DROP. Your distributor is stocked with all popular ratings in 200, 400, 600, and 1000 volts in handy Sprague Kleer-Paks. Order some today.

*Du Pont Trademark

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Introduces a new small-size bi-directional Ribbon Microphone VM-16, Velocity Type.

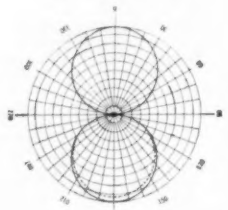
$154.95

- Superative high quality response characteristics.
- Engineered in colaboration with the Technical Research Laboratory of the Japan Broadcasting Corporation (NHK).
- Outstanding results when used for FM broadcasting and high fidelity recording because of its exacting quality of tone reproduction.
- Because of the above superior characteristics, small size and non reflecting satin-chrome finish is ideally suited for TV broadcasting.

SPECIFICATION

Frequency Response: 50-15,000 c/s ± 3 dB
Output level: - 80 dB (150 ohms/1,000 c/s)
Impedance: 150 ohms, 250 ohms or 600 ohms
Directional Characteristic: Bi-directional
S/N 20 dB or below (in parallel field at 1m gauss)

Directional Characteristic



—— 500 c/s, 1000 c/s ····· 8000 c/s,

AIWA

New Study and Economical Dynamic Microphone DM-20

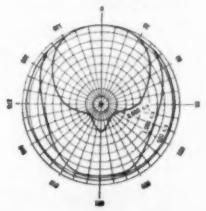
$39.50

- The DM-20 features a strong diecast body formed from exhaustive acoustical research to achieve reproduction of full audio range.
- Introduces a new plastic diaphragm free from mechanical distortion and physical deterioration.
- An exceptional dynamic microphone for studio broadcasting or recording resulting improved clear and lifelike tone quality.
- Broadens the realism of the tone reproduction in tape recording, well above currently used types of microphone.
- Reasonable priced.

SPECIFICATION

Frequency Response: 70-10,000 c/s ± 5dB
Output level: -79 dB (150 ohms, 1000 c/s)
Impedance: 50 ohms, 150 ohms, 250 ohms, 10 K ohms, and 50 K ohms.
Directional characteristic: Non-directional

Directional characteristic:



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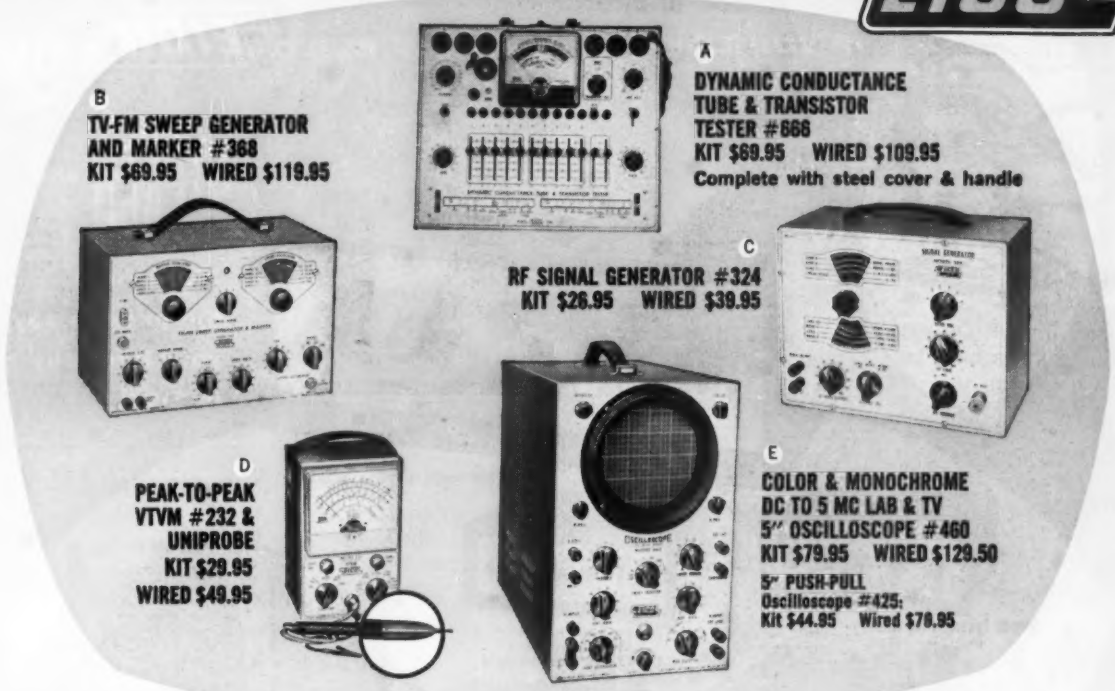

B
TV-FM SWEEP GENERATOR AND MARKER #368
KIT $69.95 WIRED $119.95

A
DYNAMIC CONDUCTANCE TUBE & TRANSISTOR TESTER #668
KIT $69.95 WIRED $109.95
Complete with steel cover & handle

C
RF SIGNAL GENERATOR #324
KIT $26.95 WIRED $39.95

D
PEAK-TO-PEAK VTVM #232 & UNIPROBE
KIT $29.95
WIRED $49.95

E
COLOR & MONOCHROME DC TO 5 MC LAB & TV 5" OSCILLOSCOPE #460
KIT $79.95 WIRED $129.50
5" PUSH-PULL Oscilloscope #425:
Kit $44.95 Wired $78.95

A Tests all receiving tubes (picture tubes with adapter), n-p-n and p-n-p transistors. Composite indication of Gm, Gp & peak emission. Simultaneous selection of any one of 4 combinations of 3 plate voltages, 3 screen voltages, 3 ranges of continuously variable grid voltage (with 5% accurate pot.). Sensitive 200 ua meter. 10 six-position lever switches: freepoint connection of each tube pin. 10 pushbuttons: rapid insert of any tube element in leakage test circuit. Direct reading of inter-element leakage in ohms. New gear-driven rollchart. **CRA Adapter $4.50.**

B Entirely electronic sweep circuit with accurately-biased increductor for excellent linearity. Extremely flat RF output. Exceptional tuning accuracy. Hum and leakage eliminated. 5 fund. sweep ranges: 3-216 mc. Variable marker range: 2-75 mc in 3 fund. bands, 60-225 mc on harmonic band. 4.5 xtal marker osc., xtal supplied. Ext. marker provision. Attenuators: Marker Size, RF Fine, RF Coarse (4-step decade). Narrow range phasing control for accurate alignment.

C 150 kc to 435 mc with ONE generator in 6 fund. bands and 1 harmonic band! ±1.5% freq. accuracy. Colpitts RF osc. directly plate-modulated by K-follower for improved mod. Variable depth of int. mod. 0-50% by 400 cps Colpitts osc. Variable gain ext. mod. amplifier: only 3.0 v needed for 30% mod. Turret-mounted, slug-tuned coils for max. accuracy. Fine and Coarse (3-step) RF attenuators. RF output 100,000 uv, AF output to 10 v.

D Uni-Probe — exclusive with EICO — only 1 probe performs all functions: half-turn of probe tip selects DC or AC-Ohms. Calibration without removing from cabinet. Measure directly p-p voltage of complex & sine waves: 0-4, 14, 42, 140, 420, 1400, 4200. DC/RMS sine volts: 0-1.5, 5, 15, 50, 150, 500, 1500 (up to 30,000 v. with HVP probe, & 250 mc with PRF probe). Ohms: 0.2 ohms to 1000 megs. 4½" meter, can't-burn-out circuit. 7 non-skip ranges on every function. Zero center.

E Features DC amplifiers! Flat from DC to 4.5 mc, usable to 10 mc. Vert. Sens.: 25 mv/in.; input Z 3 megs; direct-coupled & push-pull throughout. 4-step freq.-compensated attenuator up to 1000:1. Sweep: perfectly linear 10 cps — 100 kc (ext. cap. for range to 1 cps). Pre-set TV V & H positions. Auto sync. lim. & ampl. Direct or cap. coupling; bal. or unbal. inputs; edge-lit engraved lucite screen with dimmer control; plus many more outstanding features.

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Kit $29.95
Wired $49.95
Incl. F.E.T.; less 9V batt. Prealigned RF, IF xfmrs; push-pull audio; 6" spkr.

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NEW Power & Bias Supply for Transistorized Eqpt. #1020 •
Kit $19.95
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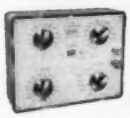
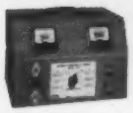
NEW Tube & CRT Fil. Tester #612
Kit $3.95
Wired $5.95
Fast-checks radio/TV tubes, pilot lamps, etc.



Series/Parallel R-C Combination Box #1140
Kit $13.95
Wired $19.95

Tube Tester #625
Kit $34.95
Wired $49.95
• tests 600 mil series string type tubes
• illuminated roll-chart
Pix Tube Test Adapter..... $4.50



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Kit $29.95
Wired $38.95
Extra-filtered for transistor equipt. **#1060 Kit $38.95 Wired $47.95**

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FM Tuner HFT90††
AM Tuner HFT94††
FM/AM Tuner HFT92††

3-Way Speaker System HFS3
2-Way Bookshelf Speaker Systems HFS5 and HFS1

NEW!

Stereo Automatic Changer/ Player 1007

100W Stereo Power Amplifier HF89
70W Stereo Power Amplifier HF87
28W Stereo Power Amplifier HF86

Stereo Integrated Amplifier AF4††

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HF81 Stereo Amplifier-Preamplifier selects, amplifies, controls any stereo source & feeds it thru self-contained dual 14W amplifiers to a pair of speakers. Provides 28W monophonically. Ganged level controls, separate balance control, independent bass and treble controls for each channel. Identical Williamson-type, push-pull EL84 power amplifiers. **"Excellent"** — SATURDAY REVIEW. **"Outstanding . . . extremely versatile."** — ELECTRONICS WORLD. **Kit $69.95. Wired $109.95.** Incl. cover.

HF85 Stereo Preamplifier: Complete master stereo preamplifier-control unit, self-powered. Distortion borders on **unmeasurable.** Level, bass, & treble controls independent for each channel or ganged for both channels. Inputs for phono, tape head, mike, AM, FM, & FM-multiplex. One each auxiliary A & B input in each channel. **"Extreme flexibility . . . a bargain."** — HI-FI REVIEW. **Kit $39.95. Wired $64.95.** Incl. cover.

New HF89 100-Watt Stereo Power Amplifier: Dual 50W highest quality power amplifiers. 200W peak power output. Uses superlative ultra-linear connected output transformers for undistorted response across the entire audio range **at full power,** assuring utmost clarity on full orchestra & organ. 60 db channel separation. IM distortion 0.5% at 100W; harmonic distortion less than 1% from 20-20,000 cps within 1 db of 100W. **Kit $89.50. Wired $139.50.**

HF87 70-Watt Stereo Power Amplifier. Dual 35W power amplifiers identical circuit-wise to the superb HF89, differing **only** in rating of the output transformers. IM distortion 1% at 70W; harmonic distortion less than 1% from 20-20,000 cps within 1 db of 70W. **Kit $74.95. Wired $114.95.**

HF86 28-Watt Stereo Power Amp. Flawless reproduction at modest price. **Kit $43.95. Wired $74.95.**

FM Tuner HFT90: Prewired, prealigned, temperature-compensated "front end" is drift-free. Prewired exclusive precision **eye-tronic®** traveling tuning indicator. Sensitivity: 1.5 uv for 20 db quieting; 2.5 uv for 30 db quieting, full limiting from 25 uv. IF bandwidth 260 kc at 6 db points. Both cathode follower & FM-multiplex stereo outputs, prevent obsolescence. Very low distortion. **"One of the best buys in high fidelity kits."** — AUDIOCRAFT. **Kit $39.95*. Wired $65.95*. Cover $3.95.** *Less cover, F.E.T. incl.

AM Tuner HFT94: Matches HFT 90. Selects "hi-fi" wide (20-9000 cps @ −3 db) or weak-station narrow (20-5000 cps @ −3 db) bandpass. Tuned RF stage for high selectivity & sensitivity. Precision **eye-tronic®** tuning. **"One of the best available."** —HI-FI SYSTEMS. **Kit $39.95. Wired $65.95.** Incl. cover & F.E.T.

New FM/AM Tuner HFT92 combines renowned EICO HFT90 FM Tuner with excellent AM tuning facilities. **Kit $59.95. Wired $94.95.** Incl. cover & F.E.T.

New AF-4 Economy Stereo Integrated Amplifier provides clean 4W per channel or 8W total output. **Kit $38.95. Wired $64.95.** Incl. cover & F.E.T

HF12 Mono Integrated Amplifier (not illus.): Complete "front end" facilities & true hi-fi performance. 12W continuous, 25W peak. **Kit $34.95. Wired $57.95.** Incl. cover.

New HFS3 3-Way Speaker System Semi-Kit complete with factory-built ¾" veneered plywood (4 sides) cabinet. Bellows-suspension, full-inch excursion 12" woofer (22 cps res.) 8" mid-range speaker with high internal damping cone for smooth response, 3½" cone tweeter. 2¼ cu. ft. ducted-port enclosure. System Q of ½ for smoothest frequency & best transient response. 32-14,000 cps clean, useful response. 16 ohms impedance. HWD: 26½", 13⅞", 14⅛". Unfinished birch **$72.50.** Walnut, mahogany or teak **$87.50.**

New HFS5 2-Way Speaker System Semi-Kit complete with factory-built ¾" veneered plywood (4 sides) cabinet. Bellows-suspension, ⅜" excursion, 8" woofer (45 cps. res.), & 3½" cone tweeter. 1¼" cu. ft. ducted-port enclosure. System Q of ½ for smoothest freq. & best transient resp. 45-14,000 cps clean, useful resp. 16 ohms. HWD: 24", 12½", 10½". Unfinished birch **$47.50.** Walnut, mahogany or teak **$59.50.**

HFS1 Bookshelf Speaker System complete with factory-built cabinet. Jensen 8" woofer, matching Jensen compression-driver exponential horn tweeter. Smooth clean bass; crisp extended highs. 70-12,000 cps range, 8 ohms. HWD: 23" x 11" x 9". Price **$39.95.**

HFS2 Omni-Directional Speaker System (not illus.) HWD: 36", 15¼", 11½". **"Fine for stereo"** — MODERN HI-FI. Completely factory-built. Mahogany or walnut **$139.95.** Blond **$144.95.**

New Stereo Automatic Changer/Player: The first & only **LUXURY** unit at a popular price! New unique engineering advances no other unit can offer **regardless of price:** overall integrated design, published frequency response, stylus pressure precision-adjusted by factory, advanced design cartridge. Compact: 10¾" x 13". **Model 1007D:** 0.7 mil diamond. 3 mil sapphire dual stylus — **$59.75. Model 1007S:** 0.7 mil & 3 mil sapphire — **$49.75.** Includes F.E.T.

†Shown in optional Furniture Wood Cabinet **WE71:** Unfinished Birch, **$9.95;** Walnut or Mahogany, **$13.95.**

††Shown in optional Furniture Wood Cabinet **WE70:** Unfinished Birch, **$8.95;** Walnut or Mahogany, **$12.50.**

EICO, 33-00 N. Blvd., L.I.C. 1, N. Y. **EW-5**
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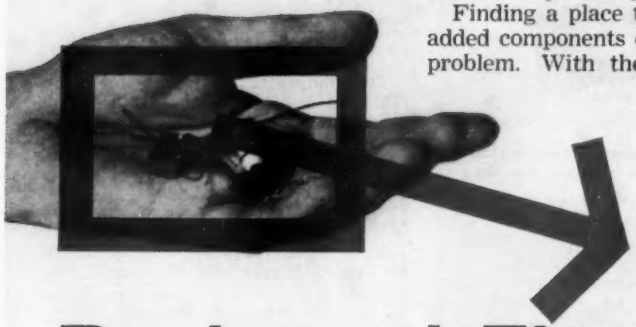


Packaged Electronic Circuits

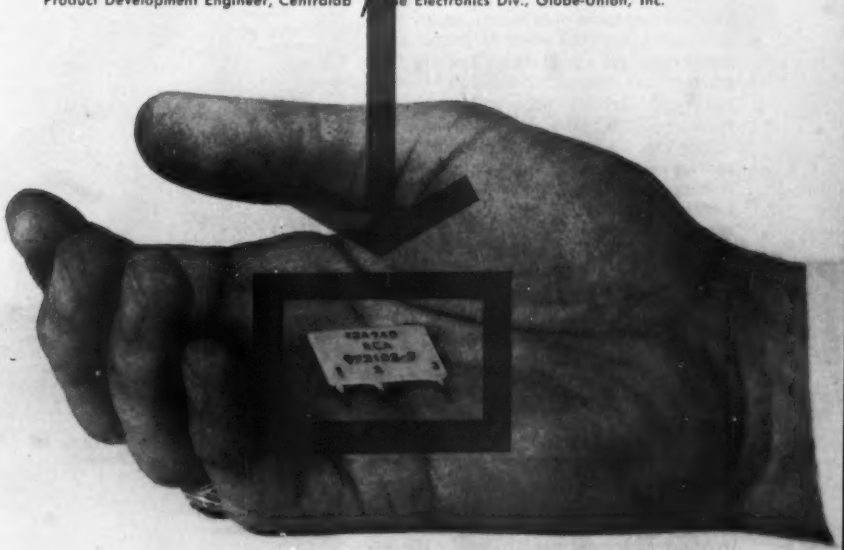
By JOHN G. KIRSCHNER

Product Development Engineer, Centralab / ...e Electronics Div., Globe-Union, Inc.

WHY would one want to use a packaged electronic circuit? This example dramatizes just one of several reasons in one of several fields: many stereo fans use ceramic cartridges for playing back discs. Most of these people would prefer to retain the convenience of using the low-level magnetic inputs of their preamplifiers for flexibility in equalization. To achieve this, the response of the ceramic cartridge must be matched to that of the magnetic input and output level must also be reduced to match that of the low-level point. In the case of one popular ceramic stereo cartridge, this requires a matching network of six components—two resistors and one capacitor per channel.

Finding a place to locate these added components can be quite a problem. With the cartridge in question it isn't: all six parts are mounted inside the tone arm! The compact, lightweight wafer in Fig. 2, shown more than twice actual size (it is less than half an inch wide), slips into place right against the cartridge. All six components have been printed on it. This is just a single example of what can be done with the packaging technique.

At a ceremony in the nation's capital last fall, leading figures in electronics gathered to commemorate production of the 100 millionth packaged electronic circuit. The occasion highlighted their increasing use since they were developed during World War II by the National Bureau of Standards and *Centralab*, the electronics division of *Globe-Union, Inc.* Their present acceptance by design engineers makes them in-



Drastically reduced component density is achieved in mass production with reliable reproducibility.

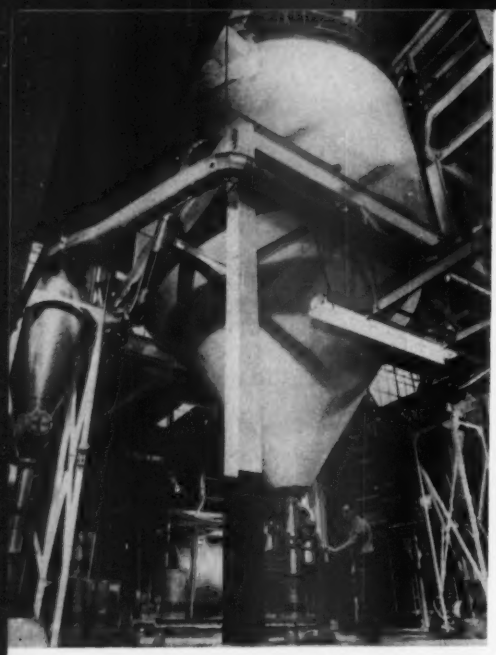


Fig. 1. Spray-drying tank for ceramic powder. Test lab is on top of tower.

creasingly important to radio-TV and industrial segments of electronics, including those concerned with servicing.

Early Uses

The two agencies noted worked together during the war to produce a complete radio transmitter and receiver that fit into a tube 3¾" long and 2" in diameter, for use as a mortar-shell proximity fuse. This fuse, Fig. 3, which used the first packaged electronic circuit, was eventually hailed as the second most important secret weapon of World War II.

With the war over, the miniaturization technique thus developed found commercial application. At first the method was used only where small size and high reliability were of prime consideration. As the state of the art improved, cost dropped to the point where packaged circuits became economical for use in the radio and TV field.

The set manufacturer found them more practical for a number of reasons. Assembling a multiplicity of components, instead of a single unit, is more expensive. Ordering, stocking, testing, and installing the single item cut costs considerably. At the same time, the degree of reliability is normally higher than with individual components.

The combination of reliability and miniaturization inherent in the packaging technique is responsible for widespread use in military and industrial applications.

There is some understandable confusion over the terms "printed" and "packaged" circuitry. The packaged circuits were originally referred to as being printed, because a printing technique was indeed used to apply the resistors, capacitors, and conductors to a ceramic base material. In time, other types of components came to be added by other methods and the term "printed circuit" was no longer applicable. Today the latter expression generally refers to a phenolic board with etched-conductor circuitry. The packaged electronic circuit, on the other hand, is a unit in which a number of various components become integral parts of a single, compact sub-assembly. Nevertheless the package may be regarded as a single component in that it is manufactured, tested, and installed as one item.

There are several basic approaches to the *form* of a packaged electronic circuit. The "module" type has a fixed size and shape in terms of length and width; its flexibility of use depends on a varying number of individual wafers stacked within the module. Another approach merely assembles individual components into a single unit that is usually encapsulated to form the package.

The PEC® approach is two-dimensional, virtually eliminating the factor

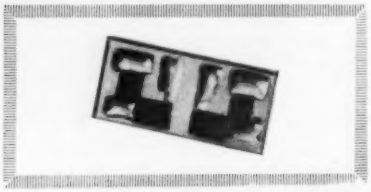


Fig. 2. Six-component cartridge-matching network, more than twice true size.

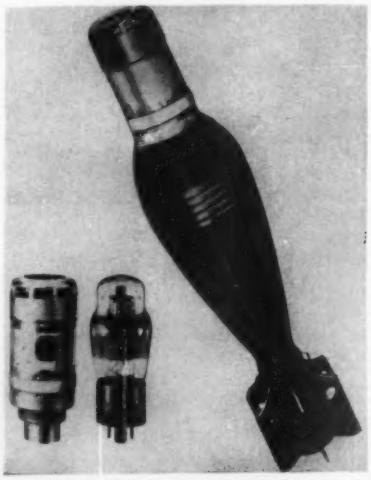
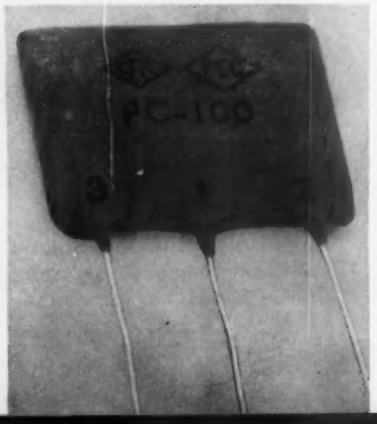


Fig. 3. Mortar shell with proximity fuse. Fuse is shown separately (left) near a 6L6 tube to give idea of size.

Fig. 4. Packaged vertical integrator.



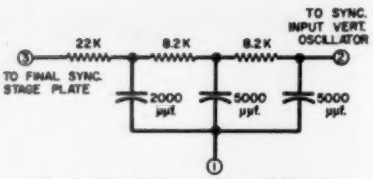


Fig. 5. Circuit for package of Fig. 4.

of thickness. This is the type most familiar to radio-TV service technicians, being used in millions of sets. These compact sub-assemblies, generally known as "Couplates," are manufactured by *Centralab* and a number of other firms including *Sprague* and *Onandaga*.

The Couplate® package uses a thin, ceramic plate as a base. This material can serve as a dielectric for capacitors that are part of the circuit. A typical Couplate and its circuit are shown in Figs. 4 and 5. As can be seen from the schematic, this vertical integrator contains six resistors and capacitors which, if installed individually, would require considerably more space and many more wiring connections.

How They Are Made

The manufacturing process for Couplates is typical of that used in the production of all packaged electronic circuits. The first step is the preparation of the ceramic base plate, for which a mixture of highly refined barium titanate and other metallic oxides provide the basic powder.

Each batch of raw material must be analyzed carefully to control the amount of impurities. These impurities, as well as others deliberately added, determine the dielectric constant, temperature coefficient, and other parameters of the finished ceramic plate. To obtain a completely uniform material, the powders are ground in a rotary mill for as long as 24 hours. A water suspension of the powder, similar to a milk shake in consistency, is made in giant mixing tanks.

The water suspension is then spray dried (Fig. 1) to provide uniform-sized particles for the pelleting or pressure forming operation. Depending on the size of the plate, the pelleting machines (Fig. 7) exert a pressure of as much as 35 tons per square inch in forming the unfired plates. A plate can contain as many as three different ceramic materials, each in a separate area. This is done when the required range of capacity values of a packaged electronic circuit is greater than can be achieved with a single material.

The pellets, or unfired plates, are then loaded in small firing boxes which are stacked and placed in firing kilns.

Firing involves a 24- to 36-hour cycle at temperatures as high as 2500 degrees F, controlled to within 5 degrees F. As little as 10 degrees F variation in temperature during firing can have a significant effect on the electrical properties of the ceramic. After firing, the units are inspected and then tumbled in rotary drums to remove any burrs or rough edges.

In the next step, the silver pattern that makes up the wiring and the capacitors is screened on the plates. See Fig. 8. A capacitor is obtained by depositing two opposing metal surfaces, one on either side of the ceramic wafer. By varying the dielectric constant of the base material, the thickness of the base plate, and the sizes of the silvered areas, a capacitance range from 10 $\mu\mu$f. to .02 μf. can be obtained, in working voltages from 50 to 2000 volts d.c.

Tolerances of both capacitors and resistors can be controlled to $\pm 5\%$, but this is rarely necessary, since it is the entire packaged circuit that is designed to meet specified performance characteristics rather than any one component included in it.

The silver pattern is screened on one side of the plate, the plate is baked lightly to dry the silver ink, and then the other side is silvered. Next firing in another kiln (1300 to 1500 degrees F) removes the vehicle and binder, leaving a pattern of pure silver. A sequence photograph (Fig. 9) shows various stages in the production of the PC-100 (vertical integrator). The center element in the top row is one side of the plate after silvering.

After a number of precise tests and controls to insure quality up to this point, the resistors are screened onto the plate. The resistive material, a carbon or graphite compound, is deposited in much the same manner as the silver pattern. The black area appearing on the plate in the center of the bottom row, Fig. 9, is a resistor. By varying the size and shape of these areas, as well as the formula of the composition, a wide range of values (5 ohms to 100 megohms) can be achieved. Once more the ceramic base plate is baked, this time to dry the resistors, and each resistor is individually adjusted to nominal value by the equipment that also tests it. A resistance bridge checks value while automatic equipment adjusts each unit to the correct reading.

The completed circuit is assembled to the leads by dipping the entire plate and the leads into molten solder, after a preheating dip in hot wax. The resistors have such excellent heat stability that they are unaffected by contact with the molten solder. The wafer now appears as shown at the upper right in Fig. 9.

At this point, the packaged electronic circuit is electrically complete and can be used in a circuit. However, for most applications the packaged electronic circuit is sealed in Durez, an encapsulating material (Fig. 6), and is vacuum wax impregnated to provide moisture protection.

The unit is then given a final test where each component and the over-all circuit performance are tested simultaneously. Automatic equipment will indicate a defective unit if only one of the many components in the package is not operating properly.

The manufacturing process differs somewhat where the circuit involves resistors only. Steatite, rather than barium titanate, is used and the rigid control of the ceramic plate processing is not required. In many applications a variety of other components, such as transistors, tube sockets, variable resistors, and hardware are attached to the base plate. These are normally put on after the resistors and capacitors.

Types of Packages

There are literally hundreds of types of packaged electronic circuits now being used in radio and TV—hundreds more in industrial applications. To give some idea of the flexibility and adaptability of PEC's, a few typical units will be described.

A recent application of particular interest to the service technician involves the incorporation of miniature variable resistors in packages. A typical unit is shown toward the top of our cover. The three variable resistors are the a.g.c., vertical-height, and vertical-linearity controls of a TV set. In addition to these controls, there are four fixed resistors on the same ceramic plate.

The unit shown is mounted to a segment of a printed-circuit board by the surrounding bracket, but other types are available without brackets for use with conventional, wired circuits, and these packages may be ordered with one to four variable resistors. One such package is included in a new voltohmmeter kit as the calibrating potentiometers. Another dual unit is shown in Fig. 10, with the knob removed from one variable resistor so that the deposited resistive path and the movable contact arm may be seen. These units are available in linear tapers from 400 ohms to 5 megohms.

The packaging technique is useful when the values of components within a particular circuit must be matched. For example, one assembly includes the circuit of a balanced FM detector stage with de-emphasis network. Providing matched pairs within this network with standard components is expensive. However, because of the inherent uniformity and reproducibility that can be

Fig. 7. This pelleting press forms ceramic plates under high pressure.

Fig. 8. Screen printing machine applies silver pattern to bare wafers.

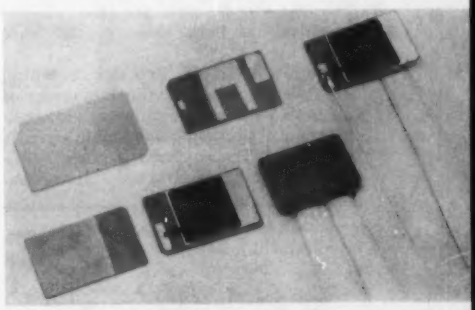


Fig. 9. From ceramic wafer to finished package. Light areas are silvered pattern; dark areas are resistive material.

Fig. 6. Completed packages get final protective dip in encapsulating compound.

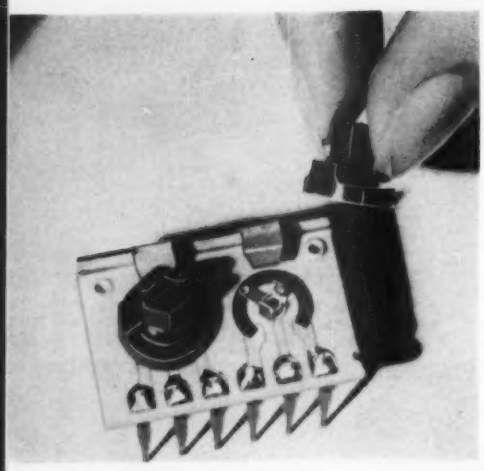


Fig. 10. Knob removed from one miniature variable resistor shows detail.

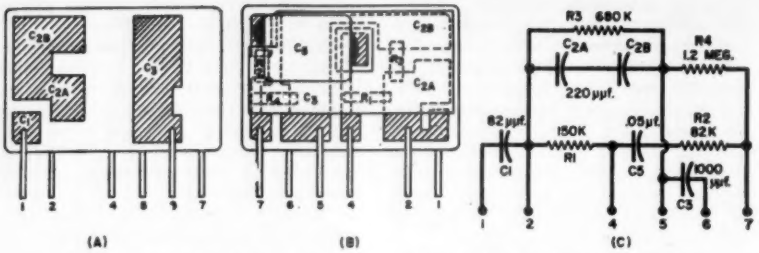


Fig. 11. Both sides (A & B) of network for TV horizontal phase detector depicts how "components" are laid out. Schematic for network (C) is also shown.

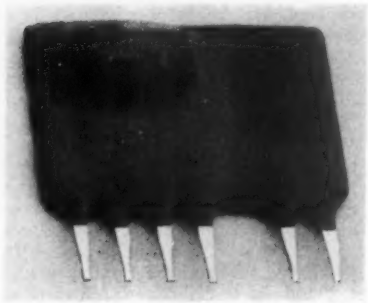


Fig. 12. Photo of phase detector package of Fig. 11. Bulge is C_5, conventional capacitor encapsulated in unit.

achieved with a PEC, an accurately matched circuit is produced as a single sub-assembly at low cost.

The phase-detector network shown in Figs. 11 and 12 is an interesting variation of the PEC technique. It is part of the circuit of the horizontal oscillator and phase comparison diodes in many 1960 *Philco* TV receivers. In this case, a .05-μf. capacitor, higher than can normally be achieved with the ceramic base plate as the dielectric, is added in the form of a conventional component prior to encapsulation. This capacitor (C_5) is the bump in the upper left portion of the packaged circuit shown in Fig. 12. The entire unit, incidentally, has external tabs for printed-board mounting instead of wire leads for use with conventional wired circuits. Packages are available in either style. Figs. 11A and 11B indicate how components are laid out and deposited on both sides of the base plate.

In addition to the cartridge matching network described at the beginning of this article, there are many other applications for packaged electronic circuits in high-fidelity equipment such as filter, bandpass, equalization, compensation, and other networks. Compact tone-control wafers are made for mounting directly on the control potentiometers. Flip-flop or frequency-dividing multivibrator networks are used extensively in electronic organs. The uniformity of these packaged electronic circuits makes them ideally suited to the repetitive circuit situations found in these organs. Depending on the size and range of the equipment, 36 to 60 packages may be used in a single instrument.

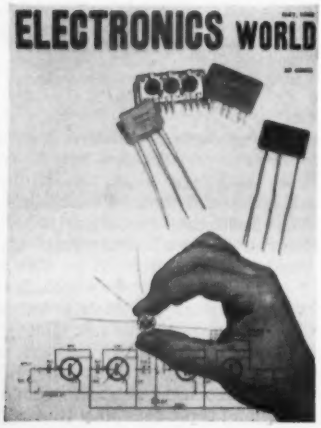
Industrial Applications

Compared to use in radio and TV, applications and shapes of the packaged electronic circuits in the industrial field are more unusual and varied, because conservation of weight and space is often more important than cost. Some idea of this variety may be obtained from Fig. 14. The ceramic plate of Fig. 14A, designed as an 11-pin tube socket, contains a network of 20 resistors. Used in the circuit of an automatic headlight dimmer, the entire unit fits inside the dimmer case mounted on the automobile dash. The unit of Fig. 14B contains three integral sockets for ultra-miniature tubes. It contains all the components for a three-stage audio amplifier used as a signal generator to check line function in the servicing of telephone-line equipment.

The *RC* network assembly of Fig. 14C was designed to fit the physical specifications of the equipment in which it is used. Containing three resistors and three capacitors, it was made to fit a plug-in unit for a computer where all circuit sections are encased in such containers. Perhaps the smallest packaged unit ever made for commercial use is the cartridge matching assembly already discussed. Measuring .447 inch wide and less than 1/16 inch thick, it has a component density of 2,300,000 per cubic foot. Component density is a standard measurement used by the armed forces to compare the relative size of components and circuits. The density achieved here is probably the highest reached in a pro-

(*Continued on page* 122)

Cover Story



THE FIVE units shown on this month's cover, although they are all small, represent a total equivalent of 48 conventional circuit components. These packaged electronic circuits demonstrate the variety and flexibility that the packaging technique makes available.

Highlighting the possibilities is the schematic diagram at the bottom of the cover, which represents a conventional four-stage transistor amplifier. All components shown, except for those in broken lines (microphone, output phone, battery, and volume control), are contained within the hand-held Centralab TA-12, winner of a Certificate of Excellence in the Miniaturization Awards Contest sponsored by Miniature Precision Bearings, Inc.

The smallest four-stage amplifier ever constructed—and it is a production unit, rather than a laboratory curiosity—it measures slightly more than half an inch in diameter and less than a quarter of an inch in height, including the sealed case. Containing twelve resistors, five capacitors, and four transistors, it weighs 1/16 of an ounce. See accompanying article for details.

The four units at the top are all used in TV receivers. To the left is a vertical integrator network replacing three capacitors with three resistors. To the right of it is a multiple miniature variable resistor, consisting of three variable and four fixed resistors. Next is a horizontal-oscillator network with five capacitors and six resistors.

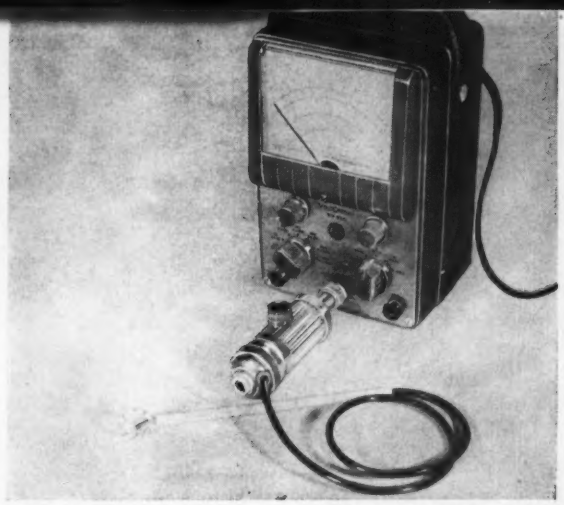
The yoke balancing circuit on the far right is shown before completion—"between dippings." When finished it will have the same tan coating of insulating Durez that can be seen on two of the other units. The red coating is a special intermediate protective insulation to inhibit the formation of corona, made necessary by the elevated voltages associated with the deflection yoke circuit. —30—

(Cover Photo by Bob Loeb)

Citizens Radio Tune-Up Meter Probe

By **HAROLD REED**

Construction of simple v.t.v.m. probe for transmitter tuning and for monitoring audio quality of the rig.



Completed probe plugged into author's v.t.v.m. Knob is sensitivity control. Phones are plugged into jack at end of the housing.

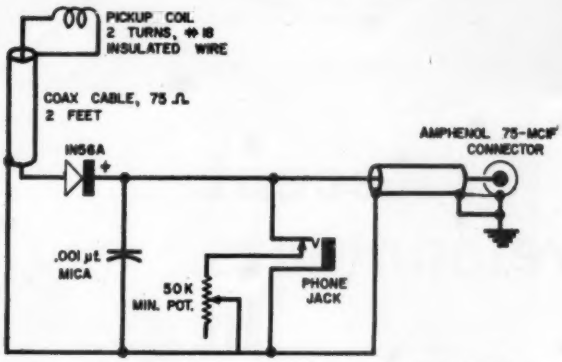
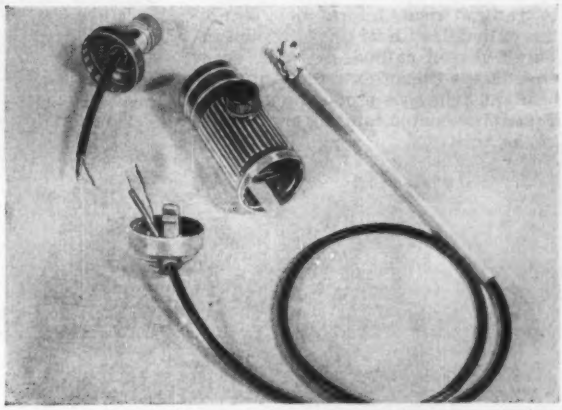


Fig. 1. Schematic diagram of simple v.t.v.m. probe described.



The tune-up device is shown ready for final assembly. The input and the output lengths of coax cable are wired in last of all.

WHEN tuning-up and adjusting any radio transmitter the job is done most quickly and efficiently by picking up a small r.f. voltage at any particular stage and tuning for maximum, as indicated by a suitable meter.

The r.f. voltage is rectified to d.c. by a diode and applied to a d.c. meter with a range of 0-1 milliampere or less. A vacuum-tube voltmeter is employed by all technicians in electronics work and, since the basic meter movement of these instruments is on the order of 200 µa., the v.t.v.m. can be adapted to serve this purpose.

Circuit Analysis

The tune-up meter circuit consists of an untuned r.f. pickup coil made up of two turns of wire coupled through coax to a germanium crystal diode. The r.f. signal is converted to d.c. by the diode and this output is applied to the connector of the v.t.v.m. which is normally used for d.c. measurements. An r.f. bypass capacitor is connected across the diode output, see Fig. 1. The meter sensitivity is adjusted by means of a variable control while a phone jack is provided for the aural monitoring of the audio signal from the transmitter.

Construction Details

The few component parts required for this device are assembled in a metal container. A metal, rather than a plastic, housing is preferable because of its shielding properties. Although any metallic enclosure will be satisfactory, the one shown in the photographs is made of parts salvaged from the junk box. These are an old split-type tube shield and two caps from an electric pull-chain lamp socket which fit snugly over the ends of the tube shield.

A mating connector for the v.t.v.m. is soldered into one of the end pieces and the monitor phone jack is mounted in the other end piece. A hole was also drilled in this latter cap and fitted with a ¼-inch rubber grommet for passage of the input coax cable.

The miniature meter-sensitivity control is mounted in the shield housing as shown and a 3-terminal stand-off is soldered to the inside of the shield for tie-point connections, including the leads of the diode and capacitor.

After wiring, the end pieces are slipped over the shield and soldered in place. A bead of solder is also run down the tiny slit where the shield butts together. There was no concern about soldering up the container in this manner since it is unlikely that anything inside will ever have to be replaced.

The r.f. probe consists of the pickup coil which is two turns of #18 insulated wire, ⅝-inch in diameter. The coil is connected to the end of a 2-foot length of small-size, 75-ohm coax cable. The coax cable fits nicely into a 6-inch length of ¼-inch plastic tubing which serves as the probe body or handle. A dab of cement at each end of the tubing will hold the coax in place. The completed device is small and easily manipulated.

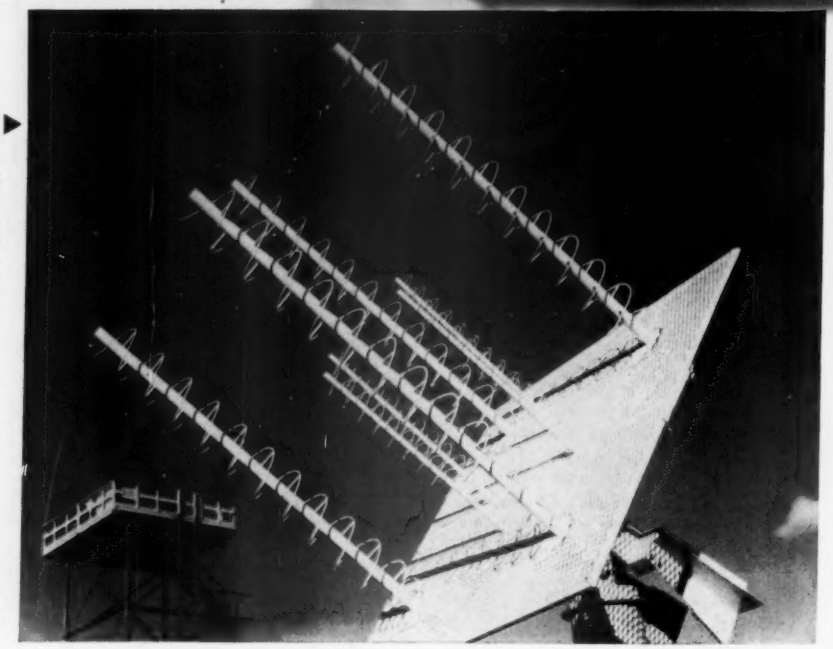
Using the Device

The pickup coil of the r.f. probe is loosely coupled to any r.f. coil of any stage of the transmitter or antenna. (*Note: The holder of a commercial radio operator's license may check and adjust the oscillator coil, but the unlicensed operator must confine his adjustments to the final r.f. amplifier or antenna circuits.*) The v.t.v.m. voltage range-switch should be set to one of the two lowest voltage ranges. The author found the 1.5- and 5-volt settings both satisfactory. The meter-sensitivity control of the tune-up adapter is then set for suitable v.t.v.m. meter deflection. The r.f. stage being checked is now tuned for maximum indication on the v.t.v.m.

Using the "VoltOhmyst" shown in the photograph, meter deflection to center scale was obtained with the voltage range-switch set to 5 volts and off-scale deflection resulted with the range-switch on the 1.5-volt position when checking various stages of the Citizens Band transmitter.

To aurally check audio modulation of the transmitter it is only necessary to plug a pair of magnetic headphones into the phone jack of the device. –30–

Recent Developments in Electronics

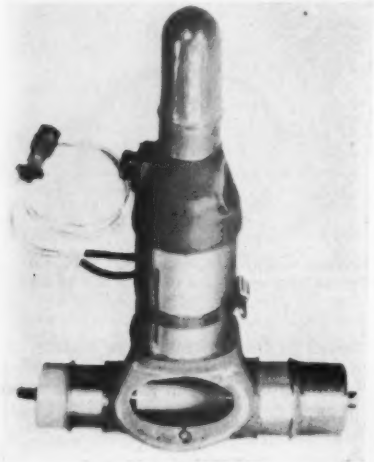


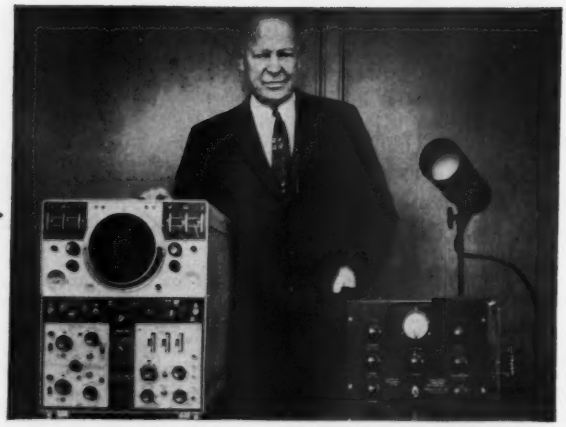
Quad-Helix Antennas for Project "Mercury"

A contract in excess of $1-million has been awarded to *Canoga* (subsidiary of the *Underwood Corp.*) for the design and manufacture of all ground-based telemetry, communications, and command-control antennas for the NASA Project "Mercury." Some fifty antenna systems in all, of the quad-helix type shown, will circle the globe to follow the path of the satellite.

Photo-Reconnaissance Tube

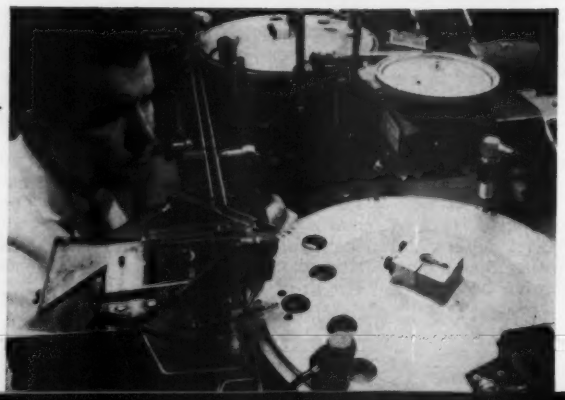
A unique new electron tube, announced by *CBS Laboratories*, makes it possible to transmit visual information, regardless of detail, with no loss of resolution. The T-shaped cathode-ray tube scans an image with an extremely fine and brilliant light spot producing a line on a phosphor-coated rotating anode within the tube.





Oldest and Newest Scopes

Dr. Allen B. DuMont, electronics and TV pioneer, compares his firm's new high-frequency, digital oscilloscope with the first commercial American unit which he developed and introduced some 30 years ago. The new scope provides a digital output that permits it to be used directly with computers.



Automatic Transistor Assembly

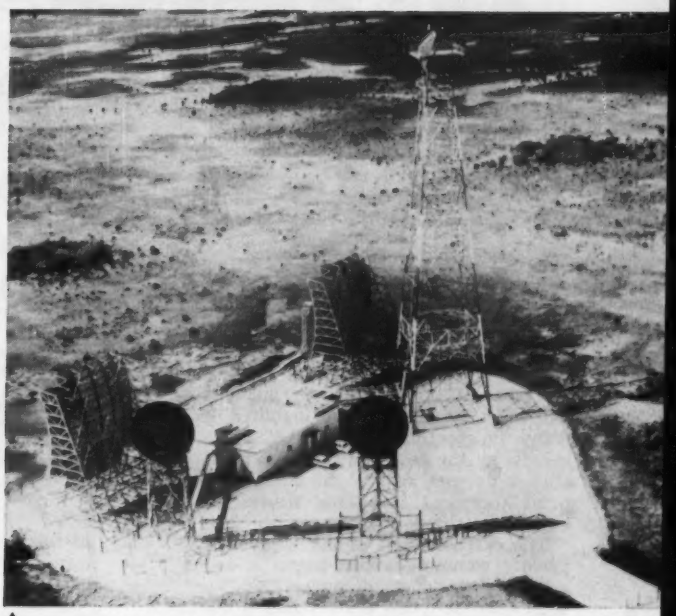
Turntables in *IBM's* new automated transistor assembly system inject transistor parts into carbon "boats" for transport on system's conveyors. Photocell and mechanical devices at each turntable signal the machine to reject units with missing or poorly positioned parts.

Computer Center to Serve Wall St. ▶

Filed away in the magnetic tape held by the operator at the new *RCA* Electronic System Center, is all the information contained in the pile of paperwork spread before her. The information can be instantly recalled by feeding the tape into the data processing system in the background. The new Center, in New York's financial district, provides electronic data processing service for banks, brokerage houses, insurance companies, and other financial-district firms.

Telemetry for Re-entering Missiles

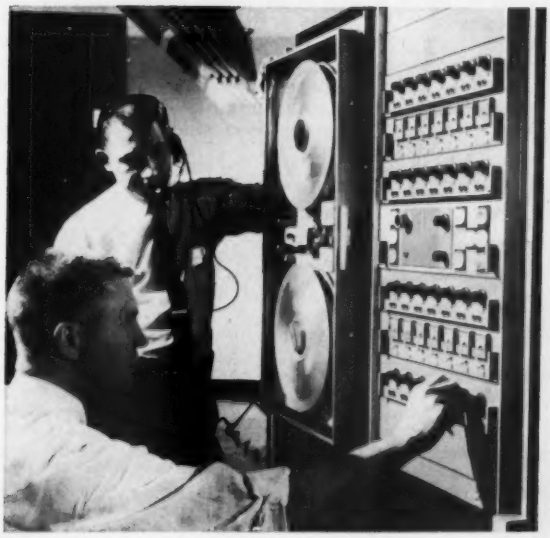
Development of a communication system which can break through the white-hot envelope of ionized air that builds up around a space vehicle re-entering the earth's atmosphere has been announced by *International Telephone and Telegraph Corp.* Called the "Direct Re-entry Telemetry System," it assures uninterrupted communication between satellites and ground stations from countdown through re-entry or retrieval. ▼



▲

New Scatter Link

Dish-like antennas at over-the-horizon tropo scatter site at Florida City, Fla. are aimed at Nassau in the Bahamas, some 186 miles away. The new system will carry 24 simultaneous telephone conversations. The square-shaped antennas on the far side of the site transmit and receive TV and telephone conversations between U. S. and Cuba. The building houses amplifying equipment for both systems, while the tower at the upper right relays signals to Miami and the national telephone network. The new link is the joint undertaking of *American Telephone & Telegraph Co.* and the Bahamas Government.



◀ Advanced Recorder for Missile Tests

Engineers are shown monitoring data output levels on the new, high-performance tape recorder being used by *Boeing* for testing the "Minuteman" intercontinental ballistic missile. The tape recorder is the first all solid-state ground analogue recorder developed by *Ampex Corp.* It will be the primary part of a system that will record signals associated with the testing of the missile, as well as signals that are telemetered prior and during missile launch and flight.

New FCC decision sets technical standards and rules in favor of private microwave systems.

By **LEO G. SANDS**

Microwave Boom Begins Anew

A RECENT decision by the FCC has given new impetus to the microwave business. Such business had been stymied by the inability of many prospective users to obtain licenses, by the developmental status of station licenses, and by the lack of explicit technical standards which the equipment should meet.

The extensive use of microwave for private communications began a decade ago, as reported in the October, 1950 issue of RADIO & TV NEWS in the article "The Microwave Era Begins." When equipment became available, two railroads, several pipe-line companies, and numerous electric utilities stepped right up and invested huge sums for microwave systems.

Microwave carried the promise of expanded communications facilities of greater reliability at lower cost. It was immediately obvious that a microwave system would require maintenance only at repeater and terminal stations spaced 5 to 100 miles apart. Every inch of a wire line, on the other hand, is subject to storm damage and requires maintenance.

The boom that started a decade ago soon slowed down. It wasn't caused by doubts as to the effectiveness or reliability of the equipment. Instead, sales dragged because many prospective users were ineligible for licenses. Many of the eligible prospects were reluctant to make large investments in microwave systems which could be licensed

A technician near top of the tower is about to position the passive reflector, communicating by walkie-talkie with a technician at the base of the tower. The antenna is to right of the walkie-talkie and is pointed upward at the top-of-the-tower reflector.

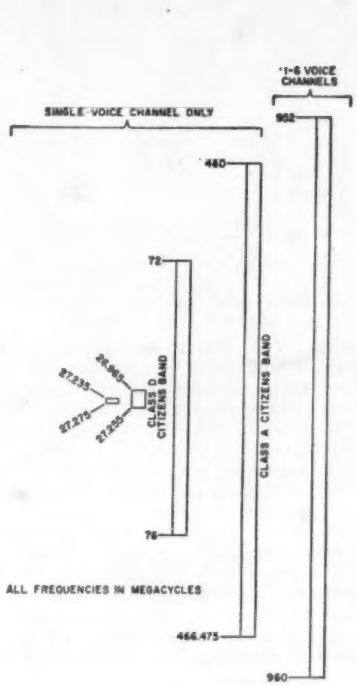
only on a *developmental* rather than on a regular basis. Furthermore, the FCC was being pressured to open up more of the microwave spectrum to the *common-carriers* (telephone companies, etc.) and to discourage expanded use of private microwave systems. There was also great opposition to the proposals.

After many months of recent hearings, the FCC has proposed specific technical standards for microwave communications systems and ruled in favor of private microwave systems as opposed to turning over much of the microwave spectrum to the telephone companies. While the public could be served either way, those in favor of expanded installation of private microwave systems opposed placing our microwave eggs in the common-carrier basket. It was the choice of telling those who need communication facilities to get service from the common carriers who would provide it by wires or radio as they chose, or letting these prospective users install their own microwave systems.

Many of the railroads, for instance, had been approached by telephone companies which offered to provide and maintain microwave facilities on a fee basis. However, the railroads asked "what priority would we have in case of storm damage or other catastrophe which would disable the system." They were told that they would not get top priority. To the railroads this is unthinkable because trains don't move without communications. No railroad could afford to wait until the telephone company could get around to restoring service.

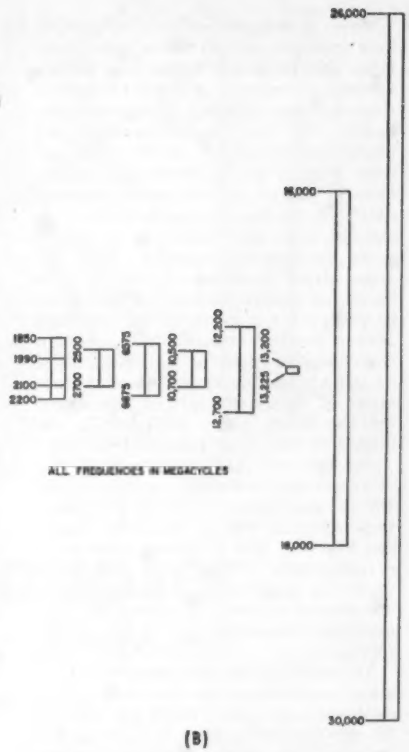
Getting a license was often conditioned on the inability of the prospective users to obtain adequate service from a common carrier. A large department store, for instance, wanted to install a microwave link between the main store and a suburban shopping center. The system was to be used for obtaining and verifying credit approval. Since the department store was then ineligible for a license, they had the choice of leasing wires as well as the associated credit transponder equipment from the local telephone company or do without.

As a result of this new policy favoring private microwave use as well as establishment of the Business Radio Service, many commercial enterprises are now planning microwave systems. Among these is a frozen orange juice processor, *Minute Maid Corp.*, which plans to tie together several fruit processing plants in Florida with a microwave system licensed in the Special Industrial Radio Service.



(A)

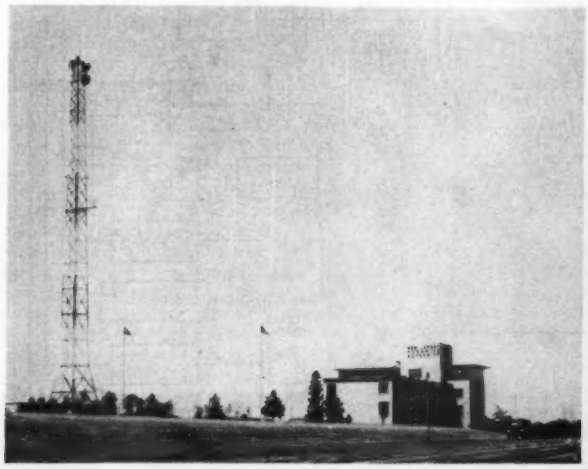
Fig. 1 (A). Chart of frequency assignments below 1000 megacycles for use by private point-to-point single-channel and multi-channel radio systems. Bands are shown about to scale.



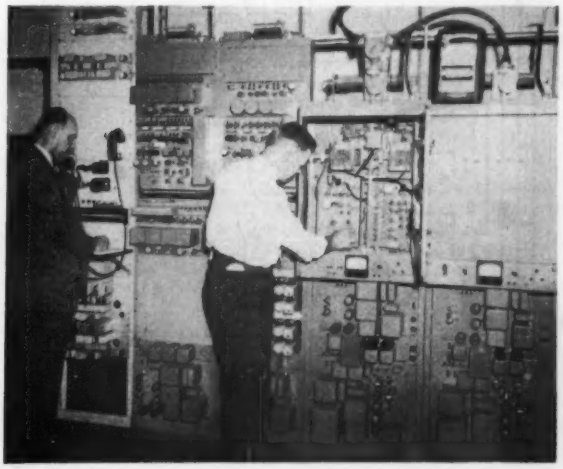
(B)

Fig. 1 (B). Chart showing the frequencies that are available above 1000 megacycles for use by private point-to-point multi-channel radio systems. Bands shown approximately to scale.

Microwave antenna tower at headquarters of the New Jersey Turnpike Authority. At tower top are 2000-mc. microwave dishes as well as pair of 152-mc. coax antennas. Half-way down tower is another pair of 152-mc. antennas. Microwave links maior points.



The Santa Fe microwave terminal station that is located in Galveston, Texas. Superintendent of the system (at left) talks over the service channel while engineer is adjusting the 6000-mc. terminal equipment. Pulse amplitude modulation is employed.



Now, any commercial enterprise, local government agencies, motor carriers, and even physicians and veterinarians are eligible to apply for microwave station licenses. There are four bands (Fig. 1A), high-frequency and ultra-high-frequency, below 1000 mc. with over 18 mc. of band space available for private point-to-point communications. In the nine bands above 1000 mc., there is over 7000 mc. of microwave band space available. And, the space above 30,000 mc. is wide open to hams and experimenters. Unfortunately, equipment is available for less than 10% of this band space, which is within the economic reach or suitable for use by private system operators. Development of reasonably priced equipment for the bands above 6875 mc. is expected in the near future. (Fig. 1B.)

Any citizen may operate a single-voice-channel radio-relay system in the 460-466 mc. band or a single-hop point-to-point radio link in the 27-mc. band. See Fig. 1A. But, a citizen engaged in a commercial enterprise is eligible to apply for licenses for a multi-channel microwave system operating at frequencies above 952 mc.—if he can afford it.

The cost of a multi-channel microwave communications system has been estimated at roughly $1000 per mile. A 10-mile single-hop class D Citizens Radio link can be set up at a cost of about $40 per mile, while a two-hop class A system spanning 50 miles can be set up for around $50 per mile.

Multiplexing and Channel Capacity

There have been few major technical changes in microwave equipment during the past decade. There are still two opposing groups, one advocating operation in the 2000-mc. band, the other favoring the 6000-mc. band. But, there has been a definite trend toward more use of frequency-division multiplexing and there is less interest in time-division multiplexing. This situation is not so much a result of technical consideration, but of practical considerations.

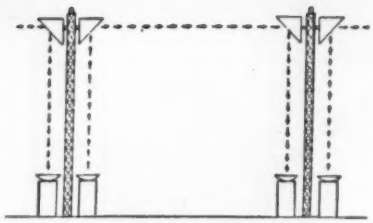


Fig. 2. Passive reflectors permit parabolic dishes to be mounted close to the ground, obviating need for long waveguide.

At a meeting of the radio and allied communications committee of the Association of American Railroads this point was brought up when a microwave equipment specification was being discussed. A representative of a manufacturer of microwave equipment that employed time-division multiplexing asked the committee why time-division equipment was not included in the specification. A committee member replied by asking the question, "What do you propose that we do with the telephone carrier equipment we are now using and in which we have several million dollars invested? We want microwave equipment over which we can transmit carrier telephone channels so we won't have to junk our existing wire-line equipment." This particular manufacturer now builds both time-division and frequency-division multiplexing.

A decade ago, microwave equipment for private use was limited in capacity from 23 to 32 voice channels. Today, there are many 120-channel systems and some 240-channel systems that can be stacked (operating at different frequencies in the same band) for operation on the same antennas to increase capacity to 720 voice channels.

While the channel capacity has been increased because of the accelerated need for more communications by railroads and other private enterprises, as well as the independent telephone companies, there is a sharply increasing demand for thin-route microwave systems. These systems can carry from two to six voice channels and fill the needs of business for interplant communication and are in demand for use as spurs linked to other microwave systems of higher channel capacity.

A voice channel may be used for conveying up to 18 AM (on-off) or FM (frequency shift) telegraph channels. These coded tones may be used for transmitting telegraphic messages, control signals, or digital information.

Technical Innovations

There have been some interesting technical innovations during the past decade. One of recent vintage is the employment of both horizontal and vertical polarization, using the same antenna reflector with dual feed elements. This provides diversity reception. The horizontally polarized and vertically polarized signals may not fade at the same time, hence, one or the other of the signals will be present most of the time.

Wider use is being made of passive reflectors (Fig. 2) which function as non-electronic repeaters. A passive reflector, which is a flat sheet of metal, acts like a mirror. It reflects the signal from the horizontally oriented dish below, in a horizontal direction to a distant station. While there is some loss in the r.f. path between the dish and

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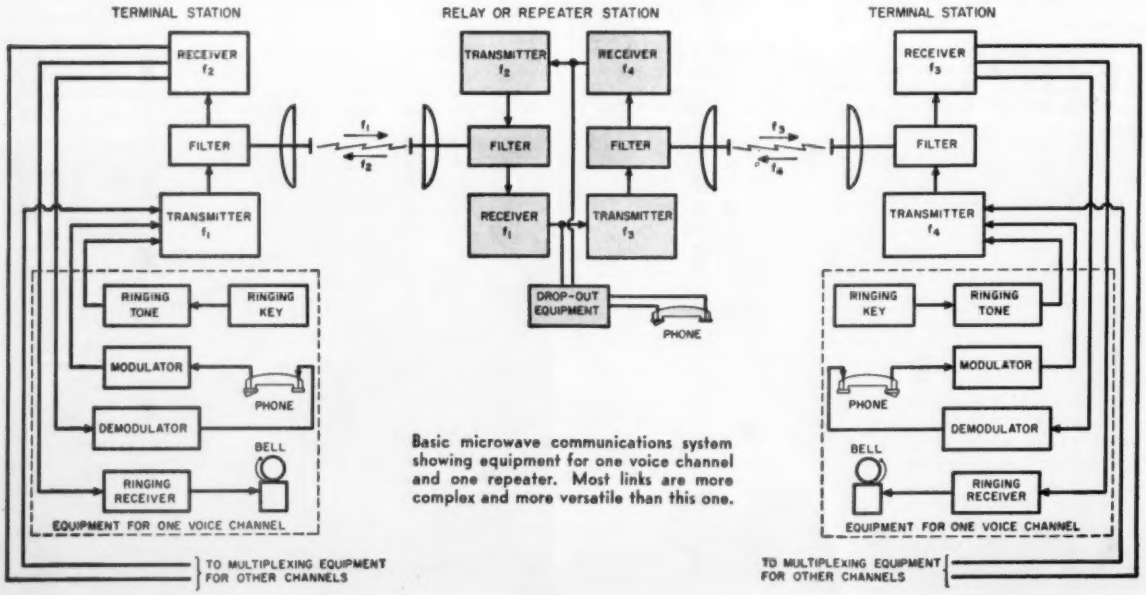
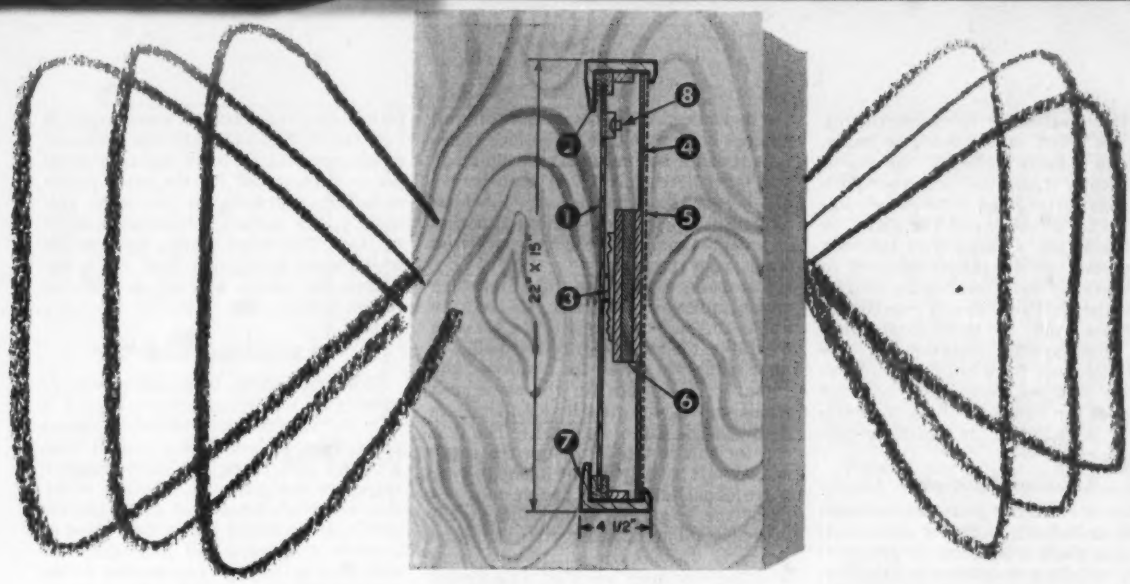


Basic microwave communications system showing equipment for one voice channel and one repeater. Most links are more complex and more versatile than this one.



The "Bi-Phonic Coupler"

A Unique Hi-Fi Speaker System

By **ABRAHAM B. COHEN**/President, Advanced Acoustics Corp.

An unbaffled system, using a large flat wooden diaphragm rather than a small paper cone to radiate hi-fi sound, promises fewer decor problems.

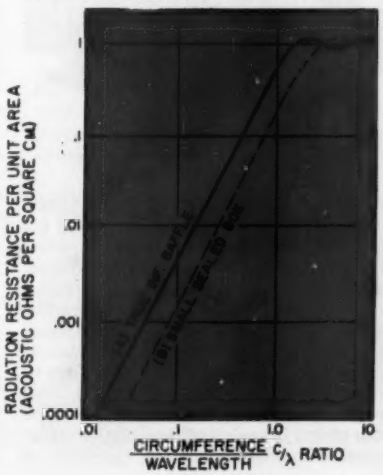
LOUDSPEAKER system design has undergone a period of evolution engendered, in the main, by the progress that has been made in the design of the "heart" of the system itself—the driver unit. In the earliest days of sound reproduction the driver unit consisted of an over-powerful earphone coupled to a "morning-glory" type horn. In fact, such a system was originally called a "loudspeaking telephone," which in due time became fore-shortened to simply "loudspeaker." The morning-glory horn of the early days was not a thing of living-room beauty, but this was not a matter of great concern, for its lack of decorative merit was compensated by the fact that it made possible the technical marvel of mechanically reproduced sound.

From these early beginnings, the loudspeaker mechanism has been improved to the point where any present advance is measurable only in the "last decimal place." This is not generally true, however, for the enclosures that up to now have been as important to the proper reproduction of sound as the loudspeaker itself. In the history of enclosure design we have gone through phases involving the large flat open baffle; the large closed box approximating the infinite baffle; the horn-loaded baffle; the bass-reflex baffle; the combined rear- and front-loaded enclosure; and, most recently, the small sealed box. These systems have ranged from large, massive, wardrobe-type of cabinetry that were awe-inspiring in size (and difficult of placement), to the very small enclosures that today are lumped into "bookshelf" category or system.

The one common characteristic of all of these systems is that, in some form or another, they are boxes that house a separate sound producer—the loudspeaker itself. These boxes must somehow be fitted into the general pattern of furniture arrangement and, because they are boxes, all have a "live" side, a "dead" back side, and must be used in such a fashion as to show their faces and hide their backs.

The loudspeaker system to be described—called the "Bi-Phonic Coupler," Fig. 2—in addition to being a radical departure from conventional design has broken through the "decor barrier." It is a *live* system in that it is not boxed. It radiates from both sides of its thin contour so that it may be placed, if desired, in the center of a room to fill the room with sound produced uniformly from both sides. Because it is thus freed from the boxed container, it is also freed from the conventional loudspeaker location areas, although it may, of course, be used in these conventional spots if desired.

Fig. 1. Radiation resistance seen by piston in small sealed box is about half that seen by the same piston in a true infinite baffle.



Of more interest to the technical man is the way in which the very deepest of bass and breadth of sound can be obtained from a system which is so radically different from conventional loudspeakers—a system which uses no conventional cone, is completely unbaffled, and produces its sound from the vibrations of a very stiffly held wooden panel which is, literally, as "stiff as a board."

Loudspeakers generally reproduce sound by the vibrations of rigid "pistons," which are loosely suspended. In general, the cone-type loudspeaker makes use of a deep-formed molded, or folded, paper cone so that it may obtain, by this construction, some measure of rigidity while it is vibrating. Such a flexibly supported rigid cone structure vibrates and produces sound when driven by an electrical signal applied to its voice coil which is immersed in the magnetic circuit. The degree to which such a rigid piston produces sound is determined by its size and how it is baffled—a baffle signifying a device which prevents the rear wave of sound

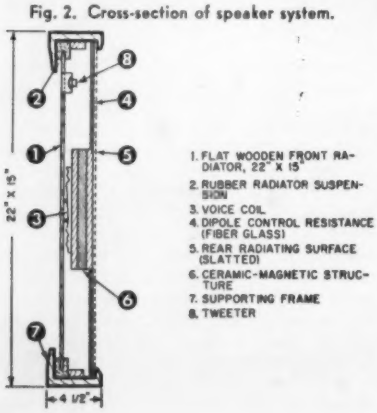
from the diaphragm from interfering with the front wave. Such a baffle, called an infinite baffle, is one which theoretically should be uniplanar with the piston surface and extends infinitely far in all directions of the plane. In actual practice, a large wall between two rooms with the piston mounted in the wall fairly well towards the *central* part of the wall very nearly constitutes an infinite baffle, for there exists complete front-to-rear isolation of the sound vibrating from both sides of the speaker. And yet, because of the large volume of the rooms involved, the loudspeaker is radiating in relatively free space on either side.

Radiation Resistance

When a vibrating piston is mounted in such an infinite baffle, its sound output, at a given frequency, is governed by the radiation resistance it "sees" at that frequency. This dependence of the radiation resistance upon piston size and applied frequency is shown graphically in Curve A of Fig. 1. It will be observed that for a given frequency (or wavelength) the radiation resistance will vary directly as the radius of the piston. Since the acoustic power that the piston can deliver is a direct function of the radiation resistance it sees, then to produce an increase in radiated power at a given frequency (for a given electrical input power) the piston radius would have to be increased. This would increase the C/λ ratio and move the radiation resistance operating point higher up on the curve. This, basically, is why a 15" speaker produces better low-frequency radiation than a 12", for example, all other controlling elements remaining unchanged.

Thus, *theoretically*, it is possible to increase the radiation resistance for a given frequency at will by going to larger and larger diaphragms with increasingly better reproduction at low frequencies. Practically, however, there are physical limitations imposed on making conventional diaphragms too large. Molded paper cones become physically unstable and do not act as true pistons when they get too large—for they begin to flex within themselves. Second, the larger they get, the deeper they must be made to maintain some measure of the mechanical stability.

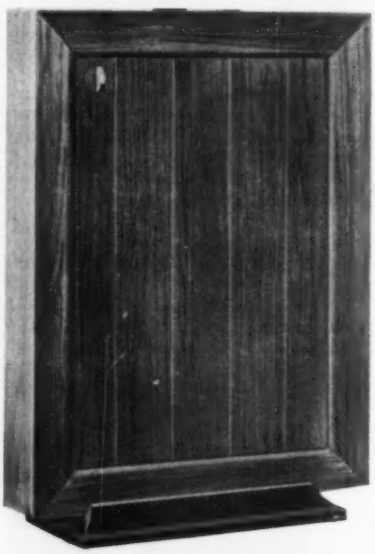
Fig. 2. Cross-section of speaker system.



Furthermore, with its accompanying magnet structure, the large size cone-type speaker becomes excessively large and deep necessitating an even larger and deeper box-type enclosure in which to house the speaker—whose function it will be to baffle the rear-radiated wave from the front.

Curves are given in the literature which indicate that for a true infinite baffle, the radiation resistance, as seen by the piston mounted in that baffle, is approximately twice the value of the radiation resistance for the same in a small sealed box; usually smaller than 8 cubic feet (Curve B, Fig. 1). The reason for this is that although the small sealed box may prevent front-to-rear wave cancellation, the piston does not "see" the large, flat, infinitely extended baffle plane. Instead, the radiation diffracts around the small box edges and thereby loses some of its forward projection radiation. The small box radiates into "full acoustic space" of 4π steradians while the true infinite baffle radiates into "half space" of 2π steradians, with, of course, an attendant power gain when it thus radiates into only half the volume of the small box. Thus, simply sealing the back end of a piston in a box does not necessarily result in optimum acoustic coupling to space.

Now, let us consider the situation which would arise were we to free ourselves from the baffle entirely. Again, we look to the established literature and find that there is a curve of radiation resistance of a piston radiating without aid of a baffle at all. This curve (Fig. 3) merely verifies what we have learned from everyday practice, namely, that for a *given* size piston radiating at a *given* frequency, radiation efficiency will be greater when baffled than when unbaffled. Thus, for instance, if the piston is sealed off and operating at some frequency such that the ratio of piston circumference to wavelength is 0.35 (as in Fig. 3A), then the radiation resistance will be 0.015 acoustic ohms per cm^2. However, for the same piston unbaffled, operating at the same frequency, the radiation resistance drops to .0001. This effect simply leads to the well-known conclusion that when unbaffled the piston will not produce as much low-frequency power as when baffled.



Coupler may be placed vertically, horizontally, or even hung directly on wall.

Unbaffled Piston

However, there is another way of looking at this relationship whereby it will be possible to realize as much power from an unbaffled piston as from a baffled one. Using the same relationships, we are going *to choose a radiation efficiency level that we might expect from a boxed piston operating at a given frequency and find what size unbaffled piston will correspond to the same radiation resistance level.* Thus, for a given level of radiation, we simply move horizontally from the baffled curve to the unbaffled curve and can now find a different circumference-to-wavelength ratio for the unbaffled piston which will produce the same radiation output as the small baffled piston ratio of piston circumference to the same wavelength. From Fig. 3B, it will be seen that for a radiation resistance of .0015 for a C/λ of .1 (small box condition), we move horizontally to the unbaffled curve and find a value close to .5. Since, however, we are maintaining the wavelength, λ, constant, then the circumference of the *unbaffled* piston will have to be approximately five times as large as the baffled one to produce the same power output at that given frequency. Thus, by simply choosing the right size radiator, we may *theoretically* reproduce, by means of an unbaffled piston, any desired low-frequency power equivalent to that of a considerably smaller *boxed* piston.

However, for purposes of adaptability to home use, a piston size of 15" x 22" was chosen and even this size is not too critical. For example, if we use the figure of .0015 radiation resistance level for a circumference-to-wavelength ratio of .1 for a baffled piston and move horizontally to some intermediate value of C/λ such as .4, which for a fixed frequency means a piston four times as large as the baffled one, then we find that we are *almost, but not directly* on the curve representing an unbaffled piston. At this point of C/λ equal to .4, which represents an *almost unbaffled piston* condition, we may expect the same level of radiation as a baffled piston of one quarter its size.

Now the expression "almost unbaffled" may seem paradoxical. This is actually only a matter of semantics for what we mean by a closed box is really a device that prevents the rear wave of the speaker from coming around to the front. Actually, then, the phrase "somewhere between a closed box and an unbaffled piston" may be restated as "at some condition of radiation where *part* of the rear wave is kept from interfering with the front wave." With this in-

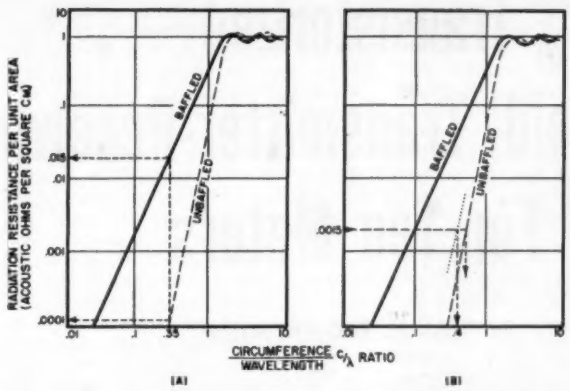


Fig. 3. (A) For a given wavelength, a fixed size piston will produce much less low-frequency power when unbaffled than when baffled. (B) However, for a given radiation level and for a given wavelength, a large unbaffled piston size may be obtained to produce the same low-frequency power as a smaller piston when in a closed box.

terpretation, it becomes fairly easy to provide the necessary control of the radiation from the back side so that the piston will operate on the intermediary characteristic indicated on the graph.

The rear-wave control is actually a combination of acoustic resistance material and an aperture screen which, together, provide just the right attenuation of the rear radiation to allow the free piston to produce the necessary output power without aid of conventional baffling. By actual measurement the rear attenuation is very small, so small in fact that only accurately calibrated measuring instruments can detect the difference in level between front and rear radiation—the ear certainly cannot hear the difference. In brief, then, by selecting a comparatively large piston and judiciously controlling the rear radiation through a *small* measure of acoustic resistance, it is possible to achieve, from the essentially *unbaffled* piston, low-frequency performance equivalent to that obtained from small pistons in sealed boxes.

Because the piston is essentially unbaffled, it performs as a dipole radiator, *i.e.*, each side acts as a radiator of acoustic energy. As a dipole radiator, the spatial distribution of the sound coming from the radiator is a "figure-8" pattern (Fig. 4), that is, there is one lobe of radiation from one side and another lobe of radiation from the other. Such spatial distribution differs considerably from that of a piston in a closed box from which the radiation is generally hemispherical for the low frequencies. For the dipole radiator, then, low-frequency orientation is more directionally positive—which is of special value in stereo reproduction. In conventional boxed systems, the diffusion of the lows throughout the room makes stereo orientation of the lows difficult but with the dipolar directivity of the unbaffled piston, this low-frequency ambiguity is eliminated.

Mechanical Problems

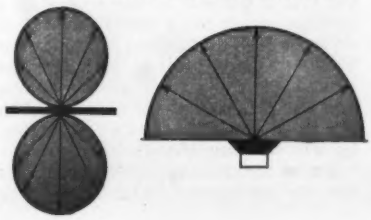
In order to provide the necessary piston action for the large radiation surface and still keep the structure flat, special methods had to be developed to obtain the necessary combination of rigidity and compliance of the panel. This was accomplished by using light, yet rigid, wood sections cemented together and braced in the rear with strategically spaced wooden members. This provides not only the necessary rigidity to the panel but is also effective in adjusting the acoustic response of the system.

Since the entire structure is made of wood, the problem was made more complicated by the fact that a single large panel of wood would not be of uniform density, nor of uniform flexure characteristics. In order to overcome this problem, the piston panel is made of five strips of selected woods—each strip having the same density and elasticity. Once these individual strips have been selected for uniformity and density, they are ready for assembly.

The type of glue or cement used is of extreme importance in maintaining vibrational strength of the panel. Simple cabinetry types of glue are not suitable in that they are essentially hard and brittle and would be shattered by the violent (although small) vibrations of the piston. Yet, on the other hand, it is not possible to use very flexible glues that would not shatter since these flexible glues would not provide the proper adhesion of the panels to provide the controlled piston action required. Accordingly, the adhesive material adopted was a specially devised combination of both thermoplastic and thermosetting types.

Once the panel had been assembled and tested, it was found to contain undesirable, although not excessive valleys and peaks. To eliminate these irregularities, it was found necessary to brace the back of the piston with strategically placed struts and mass damping elements which smoothed out the response characteristic of the piston panel. Because the wooden panel and its necessary bracing involved considerable weight (approximately 185 grams) its means of suspension became one of great stiffness, even to resonate at 20 cps. In fact, the suspension turned out to be more of a rigid clamp than a flexible support. To prevent undue mechanical noises from the piston vibrating against its clamp, a soft, compressed rubber seat which grips the piston under pressure was incorporated, allowing it to flex in this tight grip without vibrating against hard, noise-producing surfaces. Actually, this design has eliminated the flexible support of the conventional speaker cone with its attendant edge-resonance effect and structural fragility.

Fig. 4. The unbaffled piston (left) produces a figure-8 pattern while ordinary baffled speaker radiation is hemispheric.



Because the piston is so rigidly supported, there is minimum excursion of the piston as a whole which permits the voice coil, which is attached to the piston, to be practically completely linked with the magnetic gap of the circuit. In this structure, where the voice coil is so completely linked with the gap, high electrical efficiency can be obtained with magnetic non-linearity reduced to a minimum because of the practically immobile large diaphragm. High electrical efficiency invariably leads to high electrical damping, both of which together produce the conditions for excellent transient response characteristics. Moreover, the large (15" x 22") piston itself sees a high radiation resistance which is true radiation damping—effective in producing good transient response.

While the piston is, by itself, a wide-range reproducer, it was felt that seasoned audiophiles would prefer a little more highs so a tweeter was incorporated in the system. The tweeter is a high-efficiency, driver-type unit in which the radiating surface is a molded phenolic dome-type diaphragm. It is only slightly horn-loaded and has a phase-equalizing button for extending the very top range of the system. The network used is a simple high-pass filter. No effort was made to eliminate the high frequencies from the woofer section. This has two effects. First, by routing some of the high-frequency power to the woofer, there is a better balance of level between the tweeter and woofer section and, second, the middle- and high-frequency power radiated by the woofer, which comes from a comparatively large surface, minimizes the pinpoint effect of the usual tweeter radiation.

Decor and Applications

Let us now discuss some of the possibilities of decor and application inherent in this design. Instead of a cloth-covered box, the audiophile can now work with a furniture-finished, panelled structure which is decorative from both sides and whose sound is not radiated through, or impeded by, a grille cloth. Because it is so thin (4½"), it may be hung on the wall very much as a picture might be. In fact, there have been a number of inquiries regarding the possibility of painting a picture on the surface of the panel so that it would

(*Continued on page* 129)

Transistorized Hand-Held Transmitter-Receiver For Ten Meters

By NEAL H. BROWN, W7SLO

Construction of a complete self-contained, limited coverage mobile station for the radio amateur; weighs less than 2 lbs., powered with 8 penlite cells.

A HAND-HELD unit about the same size as an ordinary telephone handset, yet housing a complete receiver and transmitter, is this writer's contribution to the growing list of transistorized "goodies" for the ham.

Dubbed the "Tele-Talkie," the two units, although housed in the same case, are completely independent operationally except for a common battery power supply and center-loaded whip antenna. Switching from transmit to receive is accomplished by means of a d.p.d.t. slide switch.

Although the transmitter is limited as to power output, it is sufficient for short-range communication and should find many applications where a more powerful mobile unit could not be used because of its weight and power requirements. The unit is entirely self-contained, being powered by eight small penlite cells, and weighs less than two pounds. Since the unit is completely portable, it should be a natural for emergency work, Civil Defense communications, and similar applications.

Even though you might be out of range for transmitting, the receiver is sensitive enough to bring in messages and instructions from a more powerful net control station. The sensitivity of the receiver is such that 10-meter amateur stations have been logged from all U. S. call districts as well as several South American and South Pacific Island stations. Transmitters of this power have been known to work great distances, under ideal conditions, but this is the exception rather than the rule. This transmitter was designed expressly for short-range emergency communications and not for DX operation.

The receiver circuit is a revelation of what can be done with transistors and very low power. With less than a handful of parts and current requirements of approximately 2 ma. at 4½ volts, it is possible to come up with a receiver which has a sensitivity on the order of 4 μv. and enough audio output to be heard several feet away from the headphone unit on moderately strong signals. This sensitivity is achieved by use of superregeneration in the detector circuit. (See Fig. 1)

Since the advent of the transistor and its application in compact gear, the superregenerative principle has been revived as no other circuit gives so much for so little. The transistor superregenerative detector requires only approximately 300 μa. of current for its operation so the problem of radiation from the detector is greatly reduced over its tube counterpart. In fact, checking with a superhet receiver it was found that the local oscillator in the superhet could be heard just about as far as the superregen detector could be heard on the superhet. The superregen detector also acts as an automatic noise limiter which makes it possible to receive signals in the immediate vicinity of a motor vehicle with its motor running.

The transmitter circuit is straightforward and differs but slightly from a tube job using a similar line-up, *i.e.*, crystal-controlled oscillator, final amplifier, and modulator. The circuit has been simplified for ease of construction—for instance no tapped coils are used for feedback or coupling, thus eliminating one construction feature that often involves a messy job. Feedback to the crystal in the oscillator stage is accomplished by means of a capacitive voltage divider, consisting of C_4 and C_5, across the oscillator tank coil. Coupling into the base of the final is made with a 3-turn link wound around the bottom end of L_1. The antenna is fed by another link wound around the cold end of L_2. The oscillator uses an *RCA* 2N247 transistor in a crystal-controlled circuit which employs a third-overtone-type crystal for frequency control.

Originally, an *RCA* 2N370 transistor was used in the final amplifier and is the transistor shown in the photographs. Since then V_2 has been changed to an *RCA* 2N384 which has a higher frequency and power rating than the 2N370. By making this change the power output and efficiency of the stage was just about doubled so the slightly higher cost of the 2N384 was justified. The modulator uses a *G-E* 2N188A, the circuit being a form of Heising modulator which makes for a simple and effective type of modulation system. No speech amplifier is necessary since the output of the carbon mike used is sufficient to drive the modulator to a level which gives a good percentage of modulation.

All parts for both transmitter and receiver are mounted on a 2" x 7¼" phenolic board, except for the two switches, receiver tuning control, and the two meter jacks which are mounted on the sides of the chassis box. The mike and headphone are mounted on the front panel. The *LMB* chassis box measures 8½" long, 2⅛" wide, and 1⅝" deep. Since the mounting board is only 7¼" long this leaves enough room at the bottom of the box for the small battery pack. The phenolic board used by the author was cut from a piece of printed-circuit board which had been stripped of its copper foil. A ⅛" piece of copper strip is screwed to the left-hand side of the board and runs from top to bottom, thus serving as a common ground point for the entire circuit and simplifying the wiring job. A small hole is drilled in the board for each component lead and an ⅛" eyelet inserted and bradded down with a small center punch and hammer. These eyelets then serve as the common tie points for wiring between the different components as well as making a rigid mount for the resistors, capacitors, etc. when their leads are inserted through the eyelets and soldered into place. Where two or more parts have a common connection, a single eyelet will serve as the common tie point. This type of construction gives the effect of printed circuitry without the bother associated with this technique.

Four spacers threaded for 6-32 screws are used to mount the board in the chassis box, one at each corner to space the board ¼" from the bottom of the box. This allows room underneath the board for wiring and the placement of a few small parts. Fairly long leads are left at the points where the switches and jacks connect into the circuit so they may be wired in after installation of the board in the case.

The headphone and carbon mike are mounted on the front panel, their leads being threaded through small holes drilled in the front panel. Two surplus units were used in the author's model and mounted by cutting two rings from an old vibrator can—the mike and headphones making a tight press-fit with the rings. The ring for the mike is cut at an angle so the mike is tilted slightly upward to facilitate talking. The method of mounting may vary depending on the type of units used by the constructor. Since these components are not critical, the builder has a wide choice available to him.

The antenna is a center-loaded whip and the radiator lengths and coil windings were arrived at experimentally, using a field-strength meter and pruning the antenna and loading coil until maximum radiation was achieved. The elements for the antenna were cut from a discarded TV rabbit's ears antenna. Two brass bushings were inserted into the ends of the coil form as a tight press-fit. The bushings were drilled to accept the ends of the radiator sections, which were then secured by drilling and tapping the bushings for setscrews. The two ends of the loading-coil winding are soldered directly to the brass bushings. A *National* Type FWH feedthrough terminal strip was used to mount the antenna to the case. The two movable knurled screws were removed and two 4-40 screws soldered into their place and used to secure a 3⅛" piece of brass tubing to the mount. This piece of tubing is selected with an inside diameter just large enough to accept the bottom radiator section. This allows the antenna to be plugged in or removed quickly for transportation or storage. (See Fig. 2.)

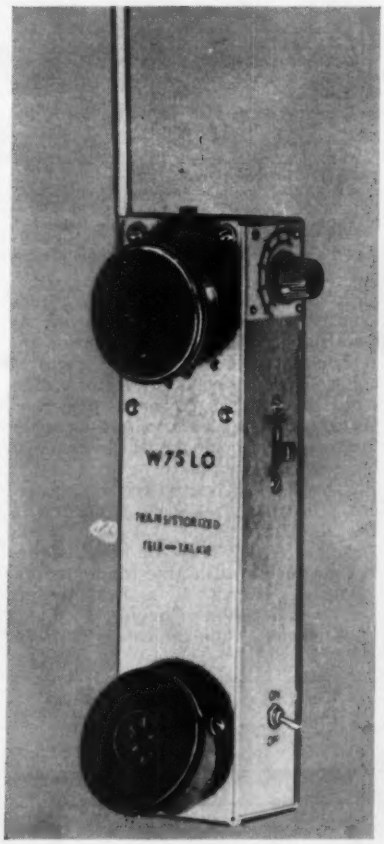
Tuning Up

After wiring of the board is completed and checked for errors, it may be given a preliminary check out and tune-up before installation in the case. To do this, temporarily wire in the headphone, mike, meter jack, switches, and receiver tuning capacitor. A word of caution here: *do not* apply voltage with the headphone disconnected as this will allow too high a voltage to be impressed on the detector with possible damage to the transistor. With these connections made and switch S_1 in the "off" position, the 12-volt battery pack (consisting of the eight penlite cells connected in series) may be connected into the circuit. In lieu of the antenna during initial tune-up, temporarily solder a No. 49 60-ma. lamp across the antenna link, L_4. This is used as a dummy load and will also serve as a modulation indicator.

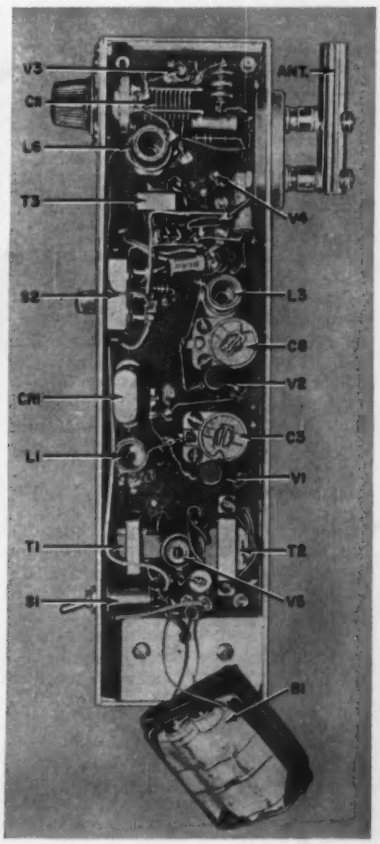
With the connections made as described, the transmitter tune-up can be started. Plug a milliammeter (minimum range 10 ma.) into J_1. Place switch S_2 in "transmit" position and switch S_1 to its "on" position. The meter is now reading the oscillator current which may run as high as 10 ma. until tuned up. Next tune capacitor C_8 until a sharp dip in current is noted on the meter. This will indicate that the oscillator is working. This dip should be down around 6 or 7 ma. The meter should then be transferred to J_2 where it will read current to the final amplifier. Capacitor C_9 should now be tuned for a minimum current reading which will run about 6 or 7 ma. The No. 49 lamp should now be glowing to indicate r.f. output from the final amplifier. A sharp whistle into the mike will cause a perceptible increase ir the glow of the lamp, indicating that modulation is being applied. If a communications receiver is available, you can monitor the signal from the transmitter and listen to the modulation—keeping the volume control low to prevent feedback between the mike and speaker.

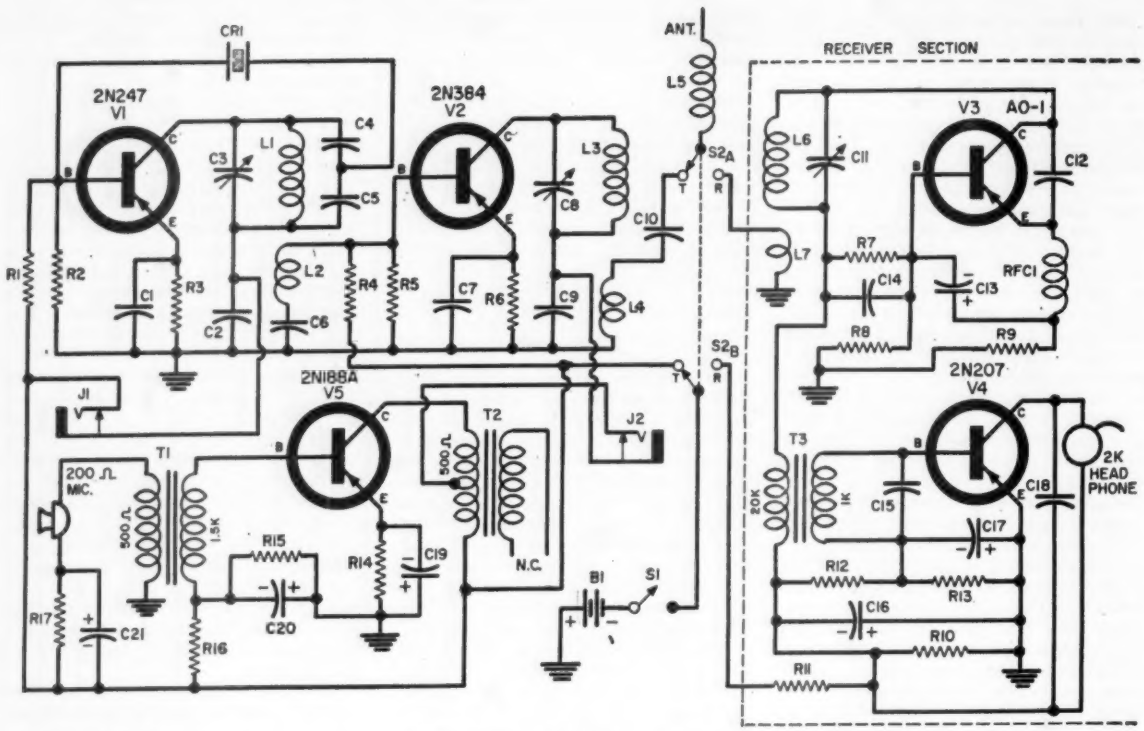
With the transmitter tuned up, the receiver may be given a check. Throw switch S_2 to the "receive" position which will apply voltage to the receiver section through the voltage dropping

Over-all view of the complete station.



Inside view showing parts layout used.





R_1—47,000 ohm, ½ w. res.
R_2, R_9, R_{13}, R_{16}—10,000 ohm, ½ w. res.
R_3—220 ohm, ½ w. res.
R_4, R_7—39,000 ohm, ½ w. res.
R_5—2400 ohm, ½ w. res.
R_6—120 ohm, ½ w. res.
R_8, R_{11}, R_{17}—1000 ohm, ½ w. res.
R_{12}—3300 ohm, ½ w. res.
R_{14}—270,000 ohm, ½ w. res.
R_{15}—50 ohm, ½ w. res.
C_1, C_3, C_7, C_9, C_{19}—.005 μf. disc ceramic capacitor
C_2, C_8—7-45 μμf. ceramic padder
C_4—18 μμf. tubular ceramic capacitor
C_5—20 μμf. tubular ceramic capacitor
C_6—300 μμf. tubular ceramic capacitor
C_{10}—50 μμf. tubular ceramic capacitor
C_{11}—2.7-19.6 μμf. miniature var. capacitor (Johnson 20M11 or equiv.)
C_{12}—10 μμf. tubular ceramic capacitor
C_{13}, C_{17}, C_{18}, C_{21}—1 μf., 6 v. elec. capacitor
C_{14}—.001 μf. disc ceramic capacitor
C_{15}—.033 μf. tubular paper capacitor
C_{16}—25 μf., 10 v. elec. capacitor
C_{20}—50 μf., 6 v. elec. capacitor
T_1—Driver trans. 1500 ohms to 500 ohms c.t. (transformer connected in reverse, 500 ohm winding used as mike winding, center-tap not used. Argonne AR-139 or equiv.)
T_2—Output trans. 500 ohms c.t. to 8 ohms (secondary not used. Argonne AR-164 or equiv.)
T_3—Driver trans. 20,000 ohms to 1000 ohms (Argonne AR-104 or equiv.)
S_1—Miniature s.p.s.t. switch ("on-off")
S_2—D.p.d.t. slide switch
J_1, J_2—Miniature closed-circuit jack
CR_1—Third overtone 10-meter crystal and socket
RFC_1—20 μhy., 600 ma. r.f. choke (Ohmite Z-28 or equiv.)
L_1—14 t. #22 en., spaced dia. of wire
L_2—3 t. #22 wound around bottom end of L_1
L_3—15 t. #22 en., spaced dia. of wire
L_4—6 t. #22 wound around bottom end of L_3
L_5—32 t. #22 en. closewound on ½" form
L_6—18 t. #22 en., spaced dia. of wire
L_7—1 t. hookup wire around bottom end of L_6
Note: All coils wound on CTC PLS5 ⅛" forms with slugs removed
Headphone—2000 ohm single headphone unit
Mic.—200 ohm carbon mike
B_1—12-volt battery (eight penlite cells wired in series)
V_1—"p-n-p" transistor (RCA 2N247)
V_2—"p-n-p" transistor (RCA 2N384, see text)
V_3—"p-n-p" transistor (Philco AO-1 or T1324)
V_4—"p-n-p" transistor (Philco 2N207 or T0037)
V_5—"p-n-p" transistor (G-E 2N188A)

Fig. 1. Circuit diagram shows that the unit employs completely separate transmitting and receiving sections.

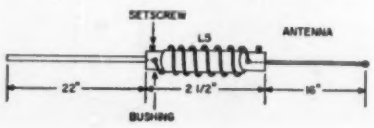
resistors R_{10} and R_{11}. This allows approximately 4½ volts to be applied to the receiver. You should now hear a rushing noise in the headphone unit, indicating that the receiver is superregenerating. Connect a short clip lead to L_7 to act as an antenna and tune capacitor C_{11}. This should produce signals on the 10-meter band. The rushing noise disappears when a signal is tuned in.

The receiver's tuning range may be checked with a signal generator or against known signals on the air. Its tuning range should be from approximately 26 mc. to well above the 10-meter band with the coils and capacitor specified in the parts list.

With the transmitter and receiver sections both working satisfactorily, the board may now be installed in the chassis using ¼" spacers and 6-32 screws to secure it to the bottom of the chassis box. The antenna mount, switches, headphone, mike, and tuning capacitor are now installed and wired into the circuit. The receiver tuning capacitor must be insulated from the chassis. This is done by mounting the capacitor on a 1¼" x 1¼" piece of phenolic board secured to the box by four 4-40 screws and nuts. The case, of course, is drilled to pass the capacitor shaft with plenty of clearance to prevent shorting.

This piece of board may also be used to prepare a dial scale if desired. A decal transfer scale was used in the original model. With the unit installed in the case, recheck the tuning as previously outlined. If a field-strength meter is available it may be used as a final check. Tune the capacitor C_8 for maximum indication on the field-strength meter.

Fig. 2. Construction of whip antenna.



Care should be taken in installing the board in the chassis to be sure that nothing shorts out against the bottom of chassis as clearance is small. If desired, a piece of insulating material may be placed in the bottom of the chassis which will prevent any accidental shorts.

A final word on using this "Tele-Talkie." This is designed for use by licensed radio amateurs and may not be operated without the pertinent FCC ticket. Although the receiver presently covers the 11-meter Class D Citizens Radio Band, the transmitter cannot be used on this band without re-adjusting the tuned circuits and substituting another crystal. Such a crystal must have a tolerance of .005% when used in the particular circuit shown. Remember that the input power is far below the 5 watts permitted for Citizens Radio use so that the operating range is extremely limited. -30-

Finding Faults in Hi-Fi Systems

Comprehensive catalogue of defects, their symptoms, and their probable causes in home audio equipment.

By **DAVID FIDELMAN**
Author, "Servicing Hi-Fi Systems"

THE REQUIREMENTS of high-fidelity reproduction are such that the equipment involved, if it is honestly made, generally will be of better-than-average quality in more ways than one. For example, it is likely to stand up relatively well under regular use. However, any electronic equipment is eventually subject to failure. When trouble crops up in a hi-fi system, understanding the types of failures that occur and their probable effects on over-all operation can greatly simplify servicing.

A complete hi-fi system is a complex chain consisting of many different components or sections. While difficulty can arise in any one section, the problems associated with each — fortunately — tend to be distinctive.

In any system, there are two general methods of locating a failure. One is to trace through the entire system to determine the section in which trouble lies, and then to conduct detailed examinations within this area until the specific trouble point is reached. The other method is to attempt recognition of the section where that trouble is probably occurring from the symptom—through experience or logic, or both. It may then be possible to proceed directly to the area of the defect, sometimes directly to the fault itself.

Of the two methods the second, although it is less "scientific," can be much faster when proper diagnosis is made. Hence, it is useful to compile and classify defects and their symptoms. Assuming normal initial operation of the system, subsequent failures rather than basic system defects will be considered here.

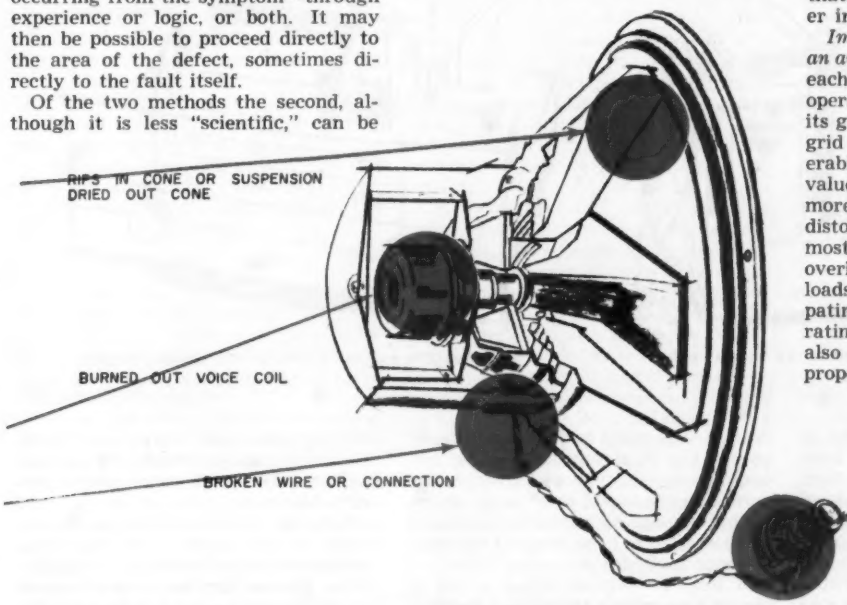
Failures in the Amplifier

Improper operation of the amplifier or preamplifier (generally, as indicated by excessive distortion) can be caused by misadjustments or changes in the circuit due to some component's degeneration, rather than from outright failure. Classes of such failures include:

Overloading. A properly designed amplifier should overload only in the output stage of the power amplifier beyond its rated output. Overloading is easily checked, since reducing the signal level will cause the distortion to be reduced. When the overload occurs below the rated output level, or obviously below a reasonable volume level, component failure in the output stage is probable. If the overloading occurs in some intermediate stage in the circuit, the most likely cause is a tube or component failure that results in a reduced load resistance across some part of the circuit, causing it to overload at a lower level than normal. In many cases the overloading is due to old or weak tubes, and clears up when the bad tube or tubes are replaced. Although any tube in the circuit can produce overloading, the fault usually occurs in driver or power-amplifier tubes.

A failure in the power supply can cause it to produce incorrect voltages, so that tubes may be operating at reduced plate voltages and thus overload at lower than normal levels. It is also possible, by improper operation of the equipment, to produce overloading in a system that has no failures. For example, if the gains and levels of the different units of the system have been misadjusted, it is possible to feed too high a level from one unit into a low-level input of the following unit and thus overload the input stages of the latter. This is easily recognized and corrected by re-adjusting the controls of the different units of the system so that they are all operating at the proper input and output levels.

Improper operating characteristic of an amplifier stage: For least distortion, each tube in the amplifier should be operating on the most linear portion of its grid-plate characteristic. When the grid or plate voltages change considerably from their original or design values, due to deterioration in one or more of the circuit components, severe distortion may be produced. Resistors most likely to change value (due to overheating) are those used as plate loads, especially when they are dissipating power at levels close to their ratings. A leaky coupling capacitor also can cause a tube to operate improperly, by applying a slight positive



Although defects in loudspeakers are not usual, here are key points to check when such failures occur.

voltage to the grid. Incorrect power-supply voltages may also be suspected.

Improper feedback can be a cause of poor amplifier performance. If the feedback circuit or one of the circuits within the feedback loop (or loops) has changed or failed, the result may be parasitic oscillation due to positive feedback, or increased distortion and poor frequency response due to the removal of adequate feedback. The components most likely to be involved are the tubes, resistors and capacitors in the feedback network, and any parasitic-suppression resistors that may be used in the power-amplifier stage. It may sometimes be necessary to change the feedback or the phase-correction network to other than the design values in order to stop a case of high-frequency oscillation. Generally, reducing the amount of feedback will help.

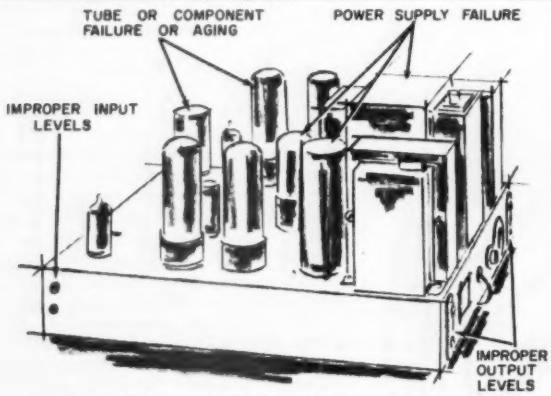
High noise level can be caused by aging or failure of some component. heater-to-cathode leakage or short circuit; unbalance in the push-pull power output stage; failure or unbalance in the d.c. biasing circuit (often associated with the heater circuitry); or a poor connection in the shielding or grounding in low-level stages.

Motorboating is a very low-frequency oscillation, due generally to coupling between high-level and low-level stages through the common impedance of the power supply. It is most frequently the result of defective electrolytic capacitors or decoupling networks, although overloading of the output transformer or unbalance in the push-pull output stage can also cause coupling through the power supply.

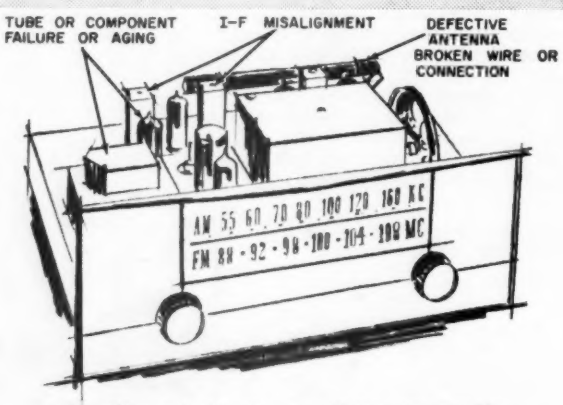
Phonograph Failures

The phonograph can be a frequent source of trouble, and its performance has become even more important with improvements in records. Improper oppbly may become defective. It may be loosely mounted or otherwise not properly coupled to the cartridge. The stylus may not be making proper contact with the record groove due to improper positioning of this assembly, or because it is bent out of shape, or because one of the pole pieces is bent or out of position (in the case of a magnetic cartridge). Stylus motion may be impeded because dust or other foreign matter has accumulated in the assembly, or against such associated portions of the cartridge as the guard or pole pieces.

Other possible failures include difficulty with the cartridge itself. A crystal or ceramic element may become broken or otherwise defective. In a magnetic cartridge, coil wires may become open or shorted, or the magnetic circuit itself may become defective. A tone arm may be damaged or improperly adjusted. There may also be some binding in its bearings or mounting, re-



Possible failures and check-points in the basic amplifier.


TUBE OR COMPONENT FAILURE OR AGING
I-F MISALIGNMENT
DEFECTIVE ANTENNA
BROKEN WIRE OR CONNECTION
AM 55 60 70 80 100 120 160 KC
FM 88 - 92 - 98 - 100 - 104 - 108 MC

Some things to look for in a tuner that is giving trouble.

Defective tubes may be the cause of thermal noise, hiss, and crackle from intermittent contacts within the tube, as well as microphonics in low-level stages due to sound pickup from vibration of the tube elements or through direct sound conduction through the mounting of the tube socket. Tubes may also cause noise because of bad contact between the tube base pins and the socket, bad grid-cap contact (if one is used), and intermittent contact between a shield and ground.

Defective resistors and capacitors can produce thermal noise (especially when carbon resistors are used in the plate circuits of low-level stages) and intermittents (for example, voltage breakdown and recovery in the dielectric of a capacitor). Volume controls and switches can be a major source of noise—loose or dirty contacts that produce momentary open circuits are the most common causes of noisy controls or switches.

Hum that is higher than normal can be caused by a failure in one or more of the following components or circuits: power-supply filter capacitor or choke; cathode bypass capacitor; tube eration can cause either complete or partial loss of performance in the record-reproducing channel, introduce severe distortion, and even cause irreparable damage to valuable records if not corrected in time. Some of the most common problems are noted here.

A worn or chipped stylus is one of the first hazards in the case of the phonograph. As this element wears, flats begin to form on the sides so that the stylus eventually assumes the shape of a chisel with sharp edges and it begins to ride in the bottom of the groove instead of gliding along the sides. On monophonic, microgroove records, this wear can be quite serious after only a few playings with a metal-tipped stylus, fewer than a hundred playings with a sapphire stylus. Where a stylus is sufficiently worn, it is even possible to ruin a long-playing record with a single playing. This hazard is considerably more serious in the case of stereophonic records.

Stylus-assembly defects are generally, although not always, the result of careless handling or other abuse of the record-playing equipment. There are a number of ways in which this assemstricting movement. High hum level, intermittent noises, or intermittent signal may indicate a loose or broken cartridge lead wire.

Turntable rotation failure can occur either in the motor or in the drive mechanism from the motor to the turntable. Causes may be: lack of power to the motor due to a failure in the electrical circuit (such as a defective switch or plug, or a break in the wiring); wiring failure in the motor; mechanical failure in the motor (for example, binding due to damaged or frozen bearings, or to gummed oil or foreign material between the armature and pole-piece); failure in the drive mechanism (for example, worn idler-wheel bearings or rubber tires; stretched rubber drive belts, insufficient friction between rubber and metal parts due to oil or grease, insufficient spring tensions); binding in the turntable shaft or defective bearings.

Trip-cycle defects are generally due to improper adjustments, binding in release or friction components, defective springs or bent parts. The electrical circuit may also be at fault here (defective trip switches and solenoids).

Other causes may be in the records themselves, which may be of incorrect size, warped, damaged, have an oversized center hole, or non-standard lead-in and run-out grooves.

Record-dropping problems are also often the fault of the records. They can be caused by records that have broken or chipped edges, that are warped, or that are too thick or too thin. Defects in the changer that can cause record-dropping problems include: bent spindle assemblies or record-selector posts; sticking or binding of sliding parts in the record selecting or push-off mechanism; bent pusher shafts; loose or improperly set push-off arms and cams.

A number of other failures can occur in record-player mechanisms, such as: wow and flutter, rumble, mechanical resonances in the tone arm or other structures, and 60-cycle or 120-cycle hum due to electromagnetic pickup. Where these are due to failures in the record-player mechanism, such as improper lubrication of the motor and mechanism, flats or binding of the idler wheel, dirty or defective bearings, grease on the idler wheel or turntable rim, loosened screws, poor electrical connections, and other such defects that have arisen in the course of normal operation of the unit, they can be corrected and eliminated by proper servicing and maintenance. However, in many cases, these distortions and defects are partly due to the basic design of the record player, and are not actually failures in the unit.

Loudspeaker Troubles

A loudspeaker properly matched to the system will rarely fail or wear out in normal use. Where such failures do occur they are most often the result of some sort of abuse to the loudspeaker. These failures include:

Burned-out voice coils due to extreme overloading caused by connecting the loudspeaker to an amplifier delivering much more power than the rating of the loudspeaker, or by accidentally connecting the 117-volt a.c. line across the voice coil.

Rips and tears in the cone or suspension are due to careless handling or insufficient precautions to protect the speaker in installation.

Poor frequency response and distortion are often found in woofer-tweeter combinations where one or both speakers has an independent level control; this control can be misadjusted to change the relative levels of the two speakers, thus giving poor frequency response and possible distortion.

Rattles are due to loose (or broken) pieces in the loudspeaker enclosure. Resonances may occur if some of the stiffening braces have come loose from the walls of the enclosure (for example, due to aging and loosening of the glue which secures them).

Acoustic feedback or mechanical feedback may develop if the location of different units in the system has been changed in such a manner that the loudspeaker can feed back acoustical or mechanical vibrations to the phonograph pickup cartridge or other low-level sections of the system.

Poor sound conditions may be due to a number of factors that have nothing to do with the electrical operation of the system itself. Improper placement of the loudspeaker system in the room, or a loudspeaker system that is not well matched acoustically to the room can be a cause of poor sound reproduction. Very often, the history of a recent change in the furnishings or decor of the room can be one cause of poor room acoustics, and thus affect the performance of the system.

Tuner Problems

Failures and deteriorations in performance of high-fidelity tuners require a different type of consideration from those which occur in ordinary radio and TV receivers. Since the performance requirements are much more critical, relatively slight deteriorations must be included as equipment failures. Some points to consider follow:

Detector failures in AM tuners can be caused by a change in the diode load, and will show up as a distorted output. The diode load resistor (generally 2 to 10 megohms) may have changed in value, or the detector or the following tube may have failed. If the tuner uses a cathode-follower type of detector, trouble may result from changes in the cathode resistor or the r.f. bypass capacitor.

Distortion in FM tuners can be caused by misalignment of the i.f. amplifier or the detector, or by regeneration in the former. Such symptoms are sometimes due to a change in the value of an i.f. transformer's damping resistor or to a failure in the bypassing components in addition to direct misalignment of the i.f. transformers.

Poor frequency response may be due to reduced r.f. or i.f. bandwidth. This can happen if any of the damping resistors across the i.f. transformers have opened or increased in value. In FM tuners, poor frequency response can also be caused by a component failure in the audio de-emphasis network.

High noise level in AM tuners may be due to misalignment of the r.f. or i.f. transformers, or to a component failure in the whistle filter (if the tuner has one). In FM receivers, noise is generally due to incomplete limiting, which can be caused by reduced sensitivity due to faulty tubes or components, or to a failure in the antenna system or lead-in wire.

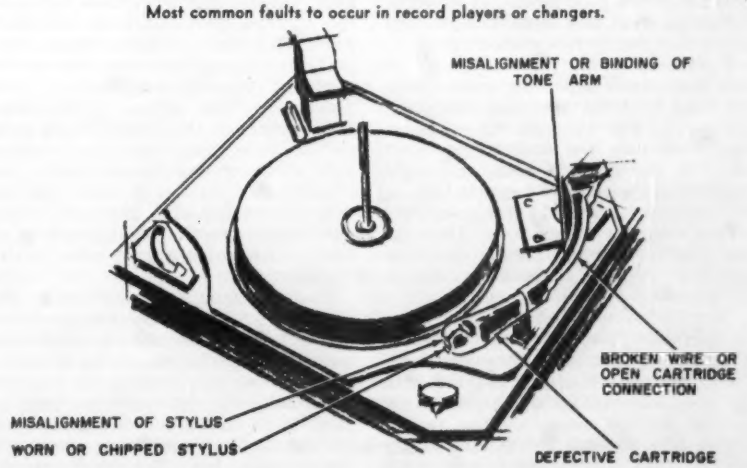
Tuners that contain preamplifiers and control units are also subject to the same failures as amplifiers and the possibility of a failure in the audio section should always be considered.

General Problems

It should always be kept in mind that failures in the system set-up itself may occur that are not defects within individual components in the system. Fortunately, these will generally be in the nature of installation errors rather than problems that develop subsequently, but the possibility of this occurrence must be considered. Sometimes such general defects, although they were part of the original installation, do not become annoyingly evident until later. Sometimes it is actually possible that a latent installation defect (a marginally good interconnection, for example) will not cause trouble for a while.

System failures are generally involved with interwiring between components (broken or fraying wires, loose connections, open grounds, ground loops, pulled-out plugs). Changes may take place because various units in the system, or even the entire system, have been moved or re-located in line with a recent attempt to redecorate the room, or even a recent cleaning of the room. For this reason, it always pays to check up on what has been happening in the room where the system is located. However, once a system has been giving satisfactory operation for some time, one would scarcely jump at such possibilities first; a failure within one of the units involved is the greater probability. —30—

Most common faults to occur in record players or changers.


MISALIGNMENT OR BINDING OF TONE ARM
BROKEN WIRE OR OPEN CARTRIDGE CONNECTION
MISALIGNMENT OF STYLUS
WORN OR CHIPPED STYLUS
DEFECTIVE CARTRIDGE

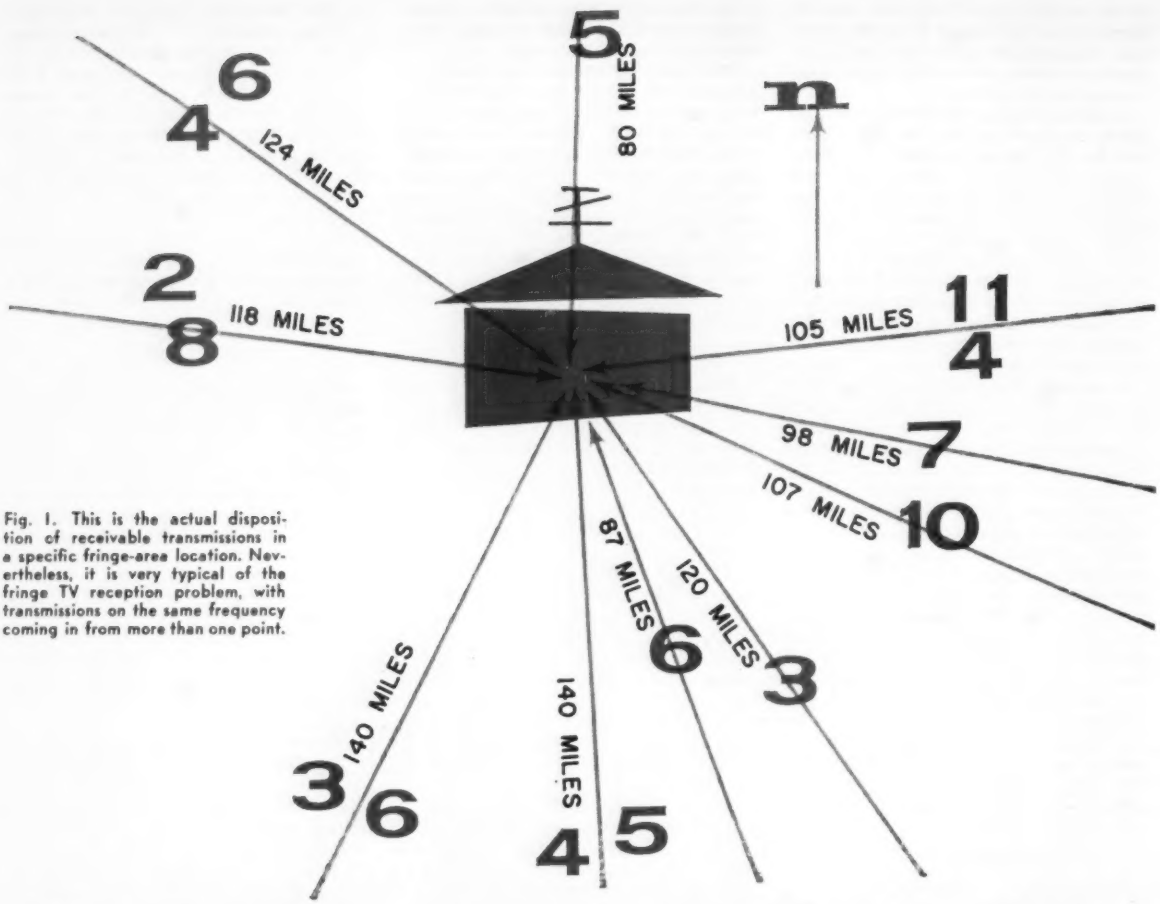


Fig. 1. This is the actual disposition of receivable transmissions in a specific fringe-area location. Nevertheless, it is very typical of the fringe TV reception problem, with transmissions on the same frequency coming in from more than one point.

TV Fringe Antenna Selection

By JACK DARR

The principal problem in outlying areas today is less one of sensitivity than it is selectivity.

THERE ARE exactly two essentials for good reception in TV fringe areas: a reasonably good receiver—and the *right* antenna system. No matter how good the set is, it isn't going to give a good picture at all without an antenna, any more than you can get a *Cadillac* to run without gas.

Furthermore the right antenna, today, may mean something quite different from what that term signified some time ago. For example fifteen years ago, with only one station 150 miles away in the author's area, we simply stacked single-channel yagis as high as we could get them and happily watched snowy pictures—if any at all. Although the results were not always ideal the problem, relatively speaking, was a simple one.

Now, what with additional stations in operation, periodic power increases over the years, and receivers with "hot" low-noise tuners, it is possible to get good, clear pictures in almost every section of the country. The typical fringe-area antenna today is no longer the multiple, single-channel yagi. It is an all-channel type that covers the tremendous range from 54 to 216 megacycles, and it may have an average gain of about 8 to 14 db on all channels.

Thus, the biggest problem now is *not* gain, but the polar-response curve of the antenna, particularly in the horizontal direction—a characteristic that will conveniently be referred to as the "pattern" for the remainder of this discussion. This pattern will involve such factors as the front-to-back ratio (FTB), "selectivity" (usually, the shape and width of the frontal lobe), the front-to-side ratio, and then gain, as well. Antennas with otherwise desirable characteristics will generally be found to have plenty of gain—where we want it.

With the number of stations on the air today, the worst reception problems in the fringe have become co-channel and adjacent-channel interference. There is only one remedy for this sort of trouble: the right antenna installation. With transmissions coming from all directions, a rotator of course becomes important. The other key element in this installation is the antenna itself. No matter how selective the input of a TV set may be, experience shows that the job of picking out the desired signal, when other competing ones are around, is placed squarely on the antenna. Failure to achieve this selection can result in a hopelessly unusable mishmash plagued by such effects as Venetian-blind and windshield wiper interference. A dramatic, common, and extremely annoying symptom of such failure shows up when the set gets the picture from one station and the sound from another (co-channel) station!

Fig. 1 is not a theoretical case that has been dreamed up for illustration. It is an actual location, with the channels indicated being those that are receivable most of the time. Now the problem begins to show up: notice the "pairings." One transmitter on channel 6 is almost back-to-back with another on the same frequency. There are similar pairings for channel 4 and channel 5. One of the channel-4 transmissions and one of the channel-6

transmissions normally come in as "strong" stations. However, if the antenna doesn't have a high enough FTB ratio, the viewer will not be able to clear up either one.

In addition, there are two transmissions on channel 3, roughly about the same distance away, and the arc they describe from the receiving point is not too many degrees wide—channel 3 southwest will often come in just strong enough, when the antenna is turned to channel 3 southeast, to produce Venetian blinds. In another case, channel 5 will make "tweed" when reception is attempted on channel 6. And so on.

The "right" antenna is the key to the problem. The ideal pattern for this reception situation is shown in the lower left-hand corner of Fig. 2. It has a single, narrow, forward lobe and does not pick up in any other direction. Also, this pattern would exist for all channels, or all those desired. The remainder of Fig. 2 shows actual patterns obtained in the field at various frequencies for three sample antennas. The antennas are identified as *A*, *B*, and *C*. To illustrate behavior on both the high and low v.h.f. bands, performance for each unit is shown on channel 4 and again on channel 8. In the case of antenna *C*, performance on channel 6 has also been shown.

Now look back at Fig. 1 and imagine that antenna *C* is installed at the receiving point, facing east to pick up channel 4 (105 miles away). One of the two rear lobes is now pointing toward channel 4, northwest, 124 miles away. In actual fact, this resulted in slight co-channel interference.

Now suppose we rotate this same antenna to pick up channel 6, south-by-southeast, 87 miles away. The tremendous side lobe is aimed directly at channel 6, southwest! In fact, on several trials with this antenna, better pictures were received off the side than from the front. In addition, due to the severe pattern breakup, gain was reduced, particularly on the high bands.

Using antenna *B* to pick up channel 6 south-by-southwest, almost the same amount of field-strength voltage was read at the set from channel 5, north! The latter produced a severe "tweed" pattern on channel 6. The interference could be minimized by detuning with the fine-tuning control, but this left an unsatisfactory picture and poor sound. When antenna *B* was tried on channel 8, the two forward lobes resulting from pattern breakup provided equally good pictures in two different positions!

With antenna *A*, whose pattern on all channels was reasonably close to the ideal, the problems described were cleared up. Fortunately antenna *A* is representative, not of a single unit, but of the top models of several different, well-known brands, and equally good results were obtained with each of these. In each the front lobe is long and sharp. Rear and side lobing due to pattern breakup are small enough not to be significant. In fact on several occasions, we were able to get clear, separate pictures from three separate transmissions on channel 4 simply by rotating the antenna. The same occurred with two different stations on channel 6.

Antennas that were close to the ideal maintained their pattern shape well over both low and high bands, and also maintained their impedance well. A large change in matching impedance, as was noted with antenna *C*, appears to be associated with pattern breakup.

So much for the theoretical angles. How can you find an antenna that will give you the desired results in your

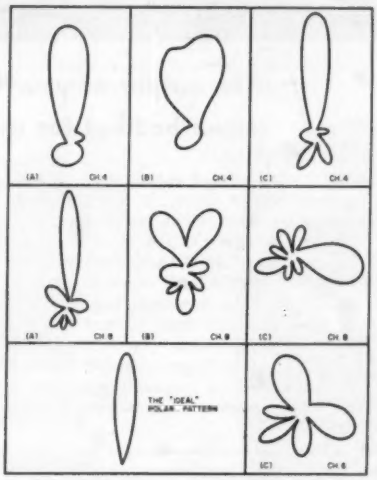


Fig. 2. "Ideal" polar response (lower left) and patterns for 3 actual units.

own area? Frankly, the best way is the one suggested in a series of liquor advertisements that ran a long time ago: "Try the Old Professor's famous test for whiskey—pour some in a glass and drink it." In other words, buy an antenna and try it *in your own area*. This sounds quite expensive. It isn't. Once you have found one antenna, or a few, that give you optimum performance, you will be spared a great deal of future trouble and expense. Furthermore, you don't have to try every unit made, willy-nilly. With a few rough rules of thumb, you can narrow the candidates down.

You may not be able to predict exact performance just by looking at an antenna, but you'll be surprised at how close you can come. The number of elements is significant—the more the better. If most of the major elements are in parallel with arriving signal, gain will probably be high. The closer the unit's general appearance is to the standard yagi configuration, the better. We *will* allow such liberties as having some of the elements slope somewhat forward, in the manner of a "vee." There is also considerable permissible variation in the form of the important dipoles. Some are simply folded, others are hairpin-like, some may be "fat."

A general picture of a modern, all-channel, fringe antenna is given in Fig. 3. Actually this represents roughly a number of different units. There are

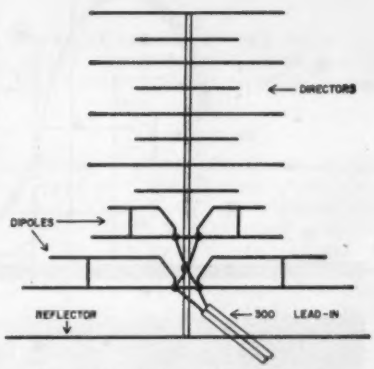


Fig. 3. The number of elements is often an indication of potential performance.

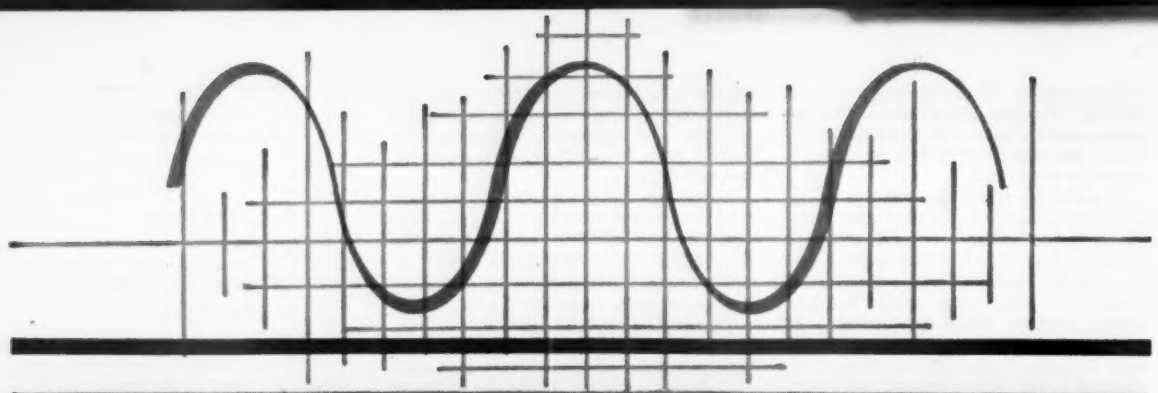
usually two active dipoles coupled by a transposition and matching harness. A number of parasitic elements are added. Many good units are designed to behave somewhat like a single yagi for the low band, and like "side-by-side" yagis on the high band.

Typical units will use a reflector and up to 6 directors. Sometimes loaded directors are used. For example, the element may be broken in the center by a small inductance. This may give the desired characteristics while keeping the element short, for good strength. Element lengths and spacings may vary from unit to unit. The idea is to adjust these carefully for good gain and close impedance match over the large spread of frequencies from 54 to 216 mc. These thoughts on antenna selection are the personal opinions of the writer, however, they were formed after quite a few years on the tops of various mountains and roofs in a deep-fringe area.

Any of the reputable, major antenna manufacturers will gladly send you full specifications on their units. They maintain their own test ranges, where each new model is put through a series of checks to determine its capabilities. Some manufacturers use standard test signals, some use TV broadcast signals, and some use both to get a complete picture of what an antenna will do. Where these firms are able to supply you with extensive test data, it becomes considerably easier to choose one of the several available types suitable for fringe use.

Now, what to do with antennas that fail to pass your own tests? You can use many of them in special locations where their defects will not interfere with performance. For example, if one type had a poor FTB ratio, you might install it in some location where it is backed up by a mountain or other obstruction. There the deficiency won't hurt a thing. Similar uses can be found for other units by taking advantage of terrain peculiarities or other circumstances unique to some individual cases.

There is a final alternative, when others fail, and this is the one we used with antenna *C*. It is now sitting peacefully in the side yard, supporting a large, climbing rose bush. It makes an elegant, rust-proof trellis! —30—



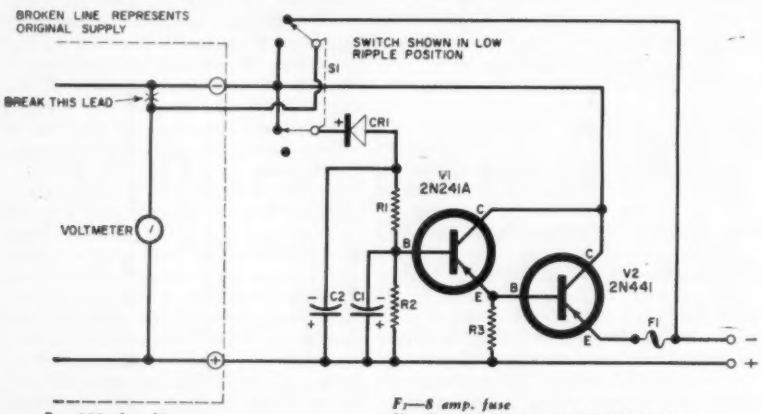
Low-Ripple Adapter

By **DANIEL MEYER**
Research Engineer, Southwest Research Inst.

The output of your battery eliminator can be smoothed out for use with transistor circuits.

THE NEED for a low-voltage d.c. supply to power auto radios when they are being worked on out of their vehicles is not new, and most established shops have their battery eliminators, battery chargers, or other such devices. The growing popularity of partially or completely transistorized car receivers, however, imposes another requirement that most of the d.c. supplies lack. The ripple content of such supplies is generally too high for use with transistorized equipment. In fact, in some older units, it may be high enough to damage the transistors.

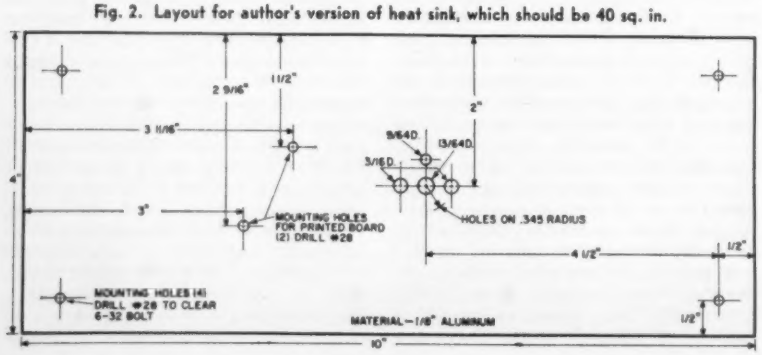
Since a low-ripple, low-voltage source comes in handy for portable transistor radios and other devices as well as for auto receivers, the need will increase. Rather than discard existing battery eliminators, most shops attempt to adapt them to meet the new requirements. A common approach is the addition of an accessory *LC* filter section. While this solution works fairly well, it is generally a rather large and expensive affair. The transistorized adapter described here does an excellent job, can be built into a small space on the original supply, and is relatively inexpensive.



R1—330 ohm, ½ w. res.
R2—1000 ohm, ½ w. res.
R3—3300 ohm, ½ w. res.
C1, C2—25 μf., 25 v. elec. capacitor
S1—D.p.d.t toggle switch
CR1—Germanium diode (1N91)
F1—8 amp. fuse
V1—"p-n-p" transistor (G-E 2N241A)
*V2—"p-n-p" transistor (Delco 2N441)**
4—1" brass stand-offs
2—¼" brass stand-offs
1—2½" x 1¾" copper laminate board
** Available from Delco Radio distributors.*

Fig. 1. The added filter becomes part of regular supply (broken lines).

Fig. 2. Layout for author's version of heat sink, which should be 40 sq. in.



Circuit

A transistor connected as an emitter-follower will give very smooth output voltage at the emitter terminal if its base is connected to a well-filtered voltage source. Power supplies of this type, designed to provide small amounts of filtered, regulated voltage for preamps and small radios, have been described in the literature.* If this circuit is modified slightly, up to 12 volts at 4 amperes can be supplied from the emitter circuit, sufficient to operate any radio now made.

Operation of the filter adapter is as follows: The output voltage of the original supply is rectified by diode CR_1 (Fig. 1) and filtered by capacitors C_1 and C_2. C_2 will charge to the peak value of the output voltage and the diode will keep it from discharging when there is ripple in the output. Resistors R_1 and R_2 form a voltage divider. Due to the small amount of current flowing in the divider, a relatively small amount of capacitance (C_1) is able to reduce the ripple at the junction of R_1 and R_2 to a very low value. Transistors V_1 and V_2 are both connected as emitter-followers. The base of V_2 is directly connected to the emitter of V_1. This makes the input resistance of V_2 and resistor R_3, in parallel, act as the emitter load for V_1. The result of this type of connection is a high input impedance at the base terminal of V_1 and a very high current gain for the combination of the two transistors.

Now by connecting the base of V_1 to the junction of R_1 and R_2, as shown in the schematic, we are able to draw up to 50 watts of well-filtered power from the emitter terminal of V_2. The output voltage will depend on the output voltage of the original supply and also on

* "Regulated Supply for Transistor Amplifiers" by H. R. Lowry, Radio & TV News, October 1957

OUTPUT CURRENT (amperes)	P-P RIPPLE IN NORMAL OUTPUT (volts)	P-P RIPPLE IN ADAPTER OUTPUT (volts)
	6-VOLT OUTPUT	
0	.02	0.
1	.7	.08
2	1.	.11
3	1.4	.14
4	1.7	.16
5	2.0	.18
6	2.3	.20
	12-VOLT OUTPUT	
0	.03	0.
1	.6	.08
2	1.2	.12
3	1.6	.19
4	2.0	.21

Table 1. Comparison of ripple in the output, with and without the adapter.

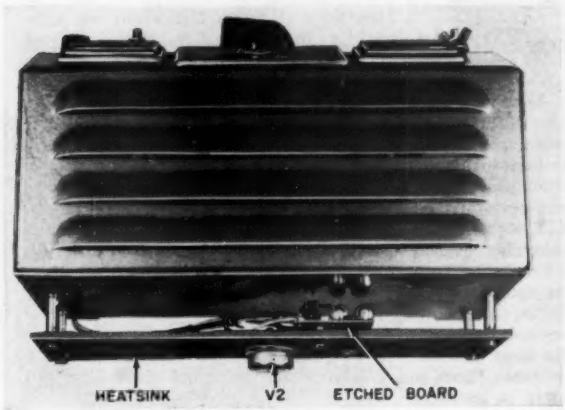


Fig. 3. Mounting of etched board to sink and sink to case.

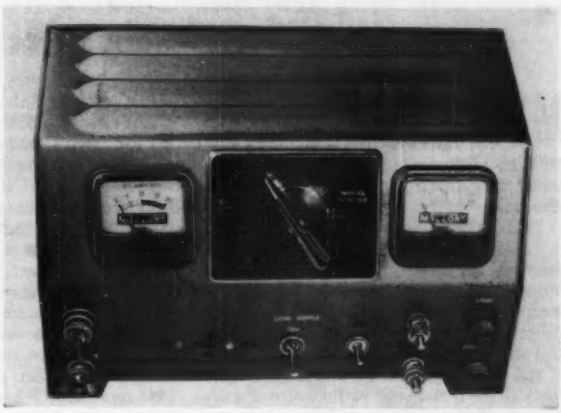


Fig. 4. Added switch and terminals on original front panel.

the values of R_1 and R_2. With the values shown for these resistors, approximately 25 per-cent of the output voltage of the original supply is dropped across the transistors. This is necessary to keep the output of the transistor circuit below the ripple from the battery eliminator even under full-load conditions.

Table 1 shows the amount of ripple in the output of the author's supply before conversion and after addition of the transistor filter adapter. Ripple was reduced approximately by a factor of ten for any given amount of current output. If even lower ripple is desired, this can be obtained by using larger capacitors C_1 and C_2.

Mechanical Considerations

The basic supply can be any 6- or 12-volt battery eliminator or similar supply. The author's unit was a *Mallory* 12RS6D. Placement of parts, not critical, may be suited to the supply being converted. Power transistor V_2 requires a heat sink of approximately 40 square inches. This can be a separate piece of metal, as shown in Fig. 2, or the case of the original supply. However, do not use the case if the area is too small or if the rectifiers in the supply conduct their heat to it. The heat sink of Fig. 2 will allow safe operation at full output (12 volts, 4 amps.) at ambient temperatures up to 125 degrees F., which is adequate.

The mica washer supplied with the power transistor should be used between the transistor and the heat sink. This is a safety measure in case the positive lead should come into contact with the heat sink. The sink was bolted to the back of the case of the battery eliminator with one-inch brass stand-offs. The stand-offs space the heat sink away from the case—far enough to make room for other components. Most of these components in the adapter were mounted on a printed circuit board. They can, of course, be assembled and wired in any other convenient way if desired, but the use of the board provides a compact, sturdy arrangement.

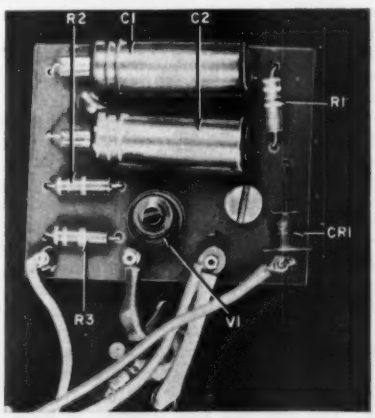
Construction

Many of those who construct this adapter may wish to experiment with the fabrication of printed-board circuits, although they have not attempted this technique before. Therefore some details are given. Actually the method is simple and inexpensive. The materials are widely available from electronic distributors, either in complete kits for making up several circuits, or as separate items. The single-faced, copper-clad, laminate board needed may be cut from a larger piece or obtained in about the desired size for something like twenty-five cents.

Other materials include a "resist" substance, to protect that portion of the copper face that is to be retained, and an etchant, to eat away the rest of the copper. The use of resist tape is probably the most convenient method in this case, especially since it is already available. *Scotch* brand type 33 electrical tape or its equivalent may be used. Ferric chloride, which is widely available, is used for the etching solution.

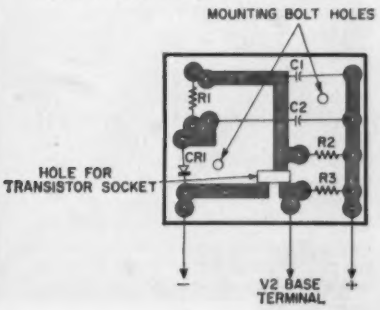
The board is cut to size and, with the

(*Continued on page* 119)

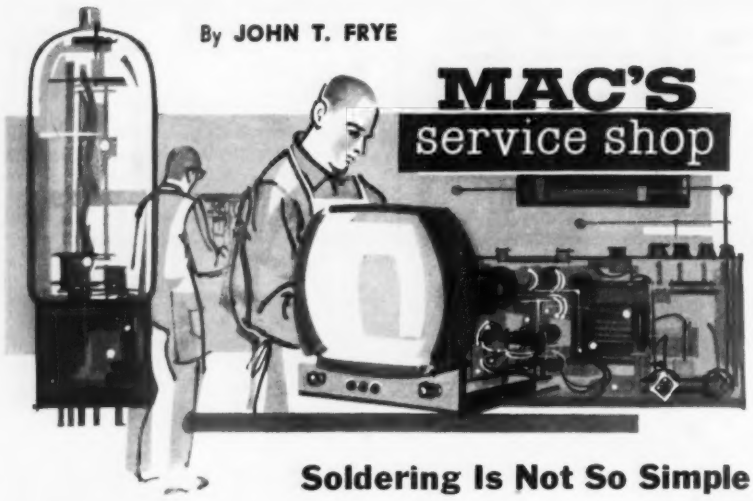


◀ Fig. 5. How parts mount on component side of etched board (2⅛ x 1¾ in.).

Fig. 6. Pattern (reduced size) to copy on copper side of laminate board.



By JOHN T. FRYE



Soldering Is Not So Simple

MAC'S face wore a broad grin as he walked into his service shop; and when Barney, his assistant, saw this, he immediately put aside the propane gas torch he had just lit and challenged:

"OK, what's so hilarious?"

"After lunch," Mac explained as he started putting on his shop coat, "I stopped in at Paul's shop to see if he wanted to go with us to that color TV meeting tonight. A customer entered the door with me and asked Paul, as a special favor, to do a hurry-up job on a little transistor radio he had with him so that he might take it along on a trip. Paul—maybe wanting to impress me a little—said, 'Sure, come back in an hour and it will be ready.'

"Now I had that same model in here a couple of weeks back; so I stuck around to watch the fun. The receiver is in an all-metal tubular case with two metal caps on the ends. I could hardly keep a straight face as I watched Paul turning that receiver over and over, ever so casually, trying to figure out how to get into it without revealing he didn't know. Finally he had to give up, just as I did, and look at the service data. When he read aloud the instructions for removing the chassis from the case, his face moved a shade nearer purple with each step and his voice went up about one octave and six db in volume. I couldn't blame him for these were the steps: 1. Remove cap from speaker end of cabinet; 2. Unsolder wire attaching cap to chassis bracket; 3. Straighten metal tab holding speaker grille to cabinet; 4. Remove metal speaker grille; 5. Lift out speaker and unsolder two speaker leads; 6. Remove volume control knob; 7. Remove tuning dial screw and tuning knob; 8. Remove screw near tuning shaft; 9. Remove screw from cap on tuning end of cabinet; 10. Slide chassis about ½" toward tuning end of cabinet; 11. Unsolder three connections from loop antenna to circuit board. Be careful to observe color coding of loop wires; and 12. Continue sliding chassis from cabinet.

"Of course this left him with the chassis free of the case but disconnected from the speaker and the ferrite core antenna; so these had to be resoldered and the dial knob and tuning knob replaced before the set could be turned on and checked. The joker was that the antenna was securely fastened in the heavy case, and the leads from this antenna were thin, fragile wires barely an inch long. With them connected, to turn the chassis-board over you had also to turn the case and the dangling speaker at the same time—a feat practically impossible to perform without breaking off one or more of the leads. And of course all these steps had to be repeated in reverse to put the thing back together. As you know, Paul's not noted for patience; and he was fit to be tied when I tiptoed away. He swore he was going to show the owner how hard it was to service and then suggest that he take it back to the guy who sold it to him and let that guy enjoy working on it."

"Can't say I blame him," Barney remarked with a sympathetic grin. "That set sounds like it was built to be thrown away when something went wrong. The sooner manufacturers get it through their heads that when they turn out a receiver especially difficult to service they are automatically recruiting a whole bunch of enthusiastic knockers for their products, the better it will be for them, for the service technicians, and for the mutual customers of both."

"OK," Mac said, "but get down off your soapbox and tell me what you're doing with the torch—besides carrying it, of course."

"When I carry a torch for a dame, that will be the day!" Barney boasted. "I was checking on something I read in this book," he went on as he nodded to a brown book with the title "Solder" in big yellow letters across its front. "Clifford L. Barber, research director of the *Kester Solder Company,* says in there you can melt ordinary table salt by heating it to a temperature of 1488° F., but you can also dissolve it with water without the use of any heat. Watch this."

Barney lit the torch and held the point of the little blue flame on a spoonful of salt heaped on top of a metal plate. In only seconds a puddle of completely clear liquid formed in a crater of the loose salt. Barney turned off the torch and poured a little water into the bottom of a glass containing another spoonful of salt. In a short time the salt dissolved and the glass contained only a clear liquid.

"Interesting," was Mac's comment, "but what's that got to do with soldering?"

"Mr. Barber is making the point that metals, just like table salt, can be *melted* by heat or chemically *dissolved.* When we join metals by melting them, as in welding or brazing, we have to use lots of heat; but when we soft-solder them together, we need just enough heat to melt our solder. The molten solder actually dissolves the surfaces of the metals it touches just the way a little water brushed on a block of salt would dissolve that surface."

"Now hold on," Mac said, showing deep interest. "Let me get this straight. You mean to tell me that soldering is actually a chemical operation? That we just use heat to convert solder to the proper form for doing its chemical job?"

"That's right. Suppose we lay a copper and a brass wire together and flow melted solder over the joint. This hot solder flows between the junction of the two wires and dissolves a bit of the surface of each wire. The dissolved copper and the dissolved brass combine with the solder to form a thin film of alloy that is not solder, not copper, and not brass; but an alloy of all three."

"Well I'll be darned!" Mac exclaimed. "Here I've been soldering all these years without realizing exactly what was happening when I pulled the trigger of the solder gun. I guess I had some sort of fuzzy notion that the two wires were kind of stuck together with a sort of super metal adhesive of good conducting properties. Now I understand that a well-soldered joint is actually a continuous metal union. Does Mr. Barber come up with any other little goodies?"

"Yes; hear this: lead melts at 620°F. Tin melts at 450°. If you start adding tin, a little at a time, to pure lead, the melting point falls steadily until you reach 63 parts tin and 37 parts lead by weight. This mixture melts at 361°. And if you start adding lead to pure tin, the melting point of the mixture also goes down from the original 450° figure until you reach that same 63/37 mixture and that same 361° temperature. This combination, which marks the lowest melting point of any tin/lead mixture, is called the *eutectic* composition.

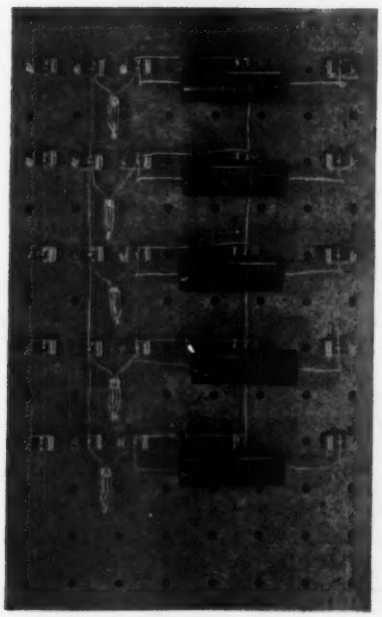
"The eutectic alloy goes sharply and immediately from a liquid to a solid state, or *vice versa,* as you cross the 361° temperature boundary. This is not

(*Continued on page* 128)

Novel Neon-Lamp Oscillators

By MICHAEL S. ROBBINS
Project Engineer, Antronic Corp.

A number of novel relaxation oscillator circuits that will be of interest to engineers and experimenters.



Breadboard setup used by author for checking out the circuits described.

VERY little has been written about glow lamps in applications other than as indicators, simple relaxation oscillators, and regulators. This article presents a number of novel relaxation oscillator circuits which should be of interest to both engineers and experimenters.

All of the circuits accompanying this article have been tested with a wide range of voltages and parts values. Parts values, except where indicated, are given as *guides for experimentation*.

The standard *module* from which all the circuits were derived is shown in Fig. 1A. For experimentation, an assembly including five or six such modules can be constructed using *Fahnestock* clips and pegboard, as shown in the photograph. The high values of resistance and capacitance indicated facilitate observation of the flashing lamps.

The common relaxation oscillator circuit is shown in Fig. 1B, while the oscillator waveform is given in Fig. 2A. This circuit has been used as a flashing indicator, audio tone generator, scope sweep generator, TV bar generator, and in many other applications where an inexpensive, non-linear, saw-tooth oscillator is required. A variation of the circuit is shown in Fig. 1C. (Try it. It actually works!)

Multi-lamp relaxation oscillators have many interesting features. The characteristics of the two-lamp circuit shown in Fig. 1D is somewhat analagous to the free-running, twin-triode multivibrator.

Like the multivibrator, the two-lamp oscillator has two states; the first when lamp #1 is on and lamp #2 off, and the second when #2 is on and #1 is off. This circuit has practical and amusement value as a sequence flasher. As in the case of the multivibrator, it generates useful square waves. The waveform across R_1 is shown in Fig. 2B. If the output is taken off between points "A" and "B," the output voltage will be slightly higher but the negative peak, as well as the positive peak, will be sloped.

Using the parts values indicated in Fig. 1D, approximately 0.5 volt is developed across R_1 ("B+" = 375 volts). The operating frequency is approximately 200 cps. The positive peak can easily be clipped and near-perfect square waves obtained by shunting a diode clipper across R_1.

The next obvious extension of the sequence flasher is shown in Fig. 3. Each lamp is lit for one-third of the total operating time. Although one cannot predict the direction of rotation (1,2,3, or 3,2,1) or which lamp will fire first, once the pattern is established it will remain stable.

(*Continued on page 82*)

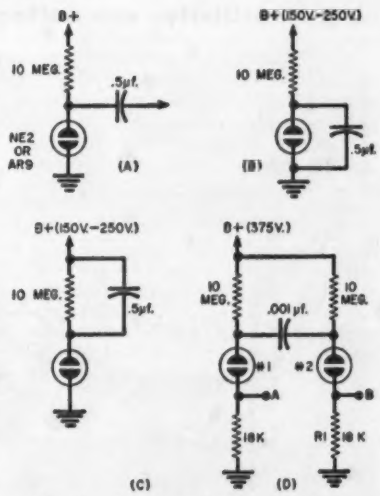


Fig. 1. Basic relaxation oscillators.

Fig. 2. Waveforms produced by circuits that are discussed by author. See text.

Compact 20-Watt Hi-Fi Amplifier

By **HAL WITTLINGER**
Electron Tube Div., Radio Corp. of America

Easy-to-build circuit with low distortion, high sensitivity, and voltage regulation.

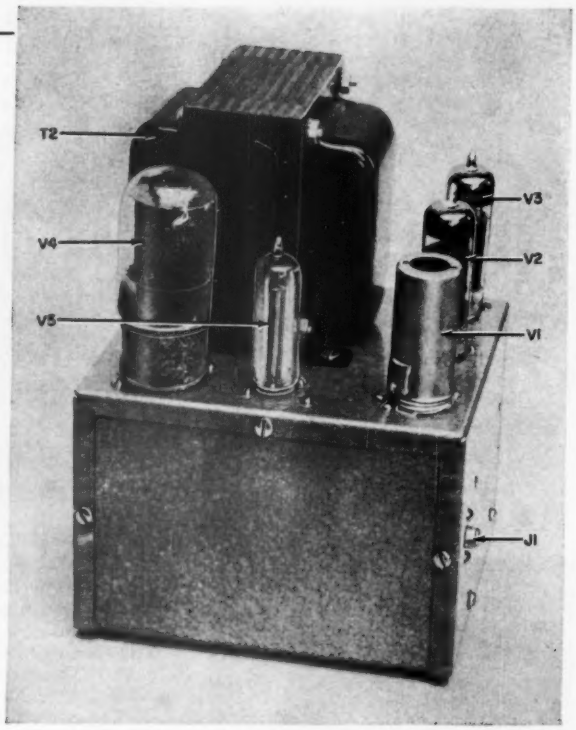
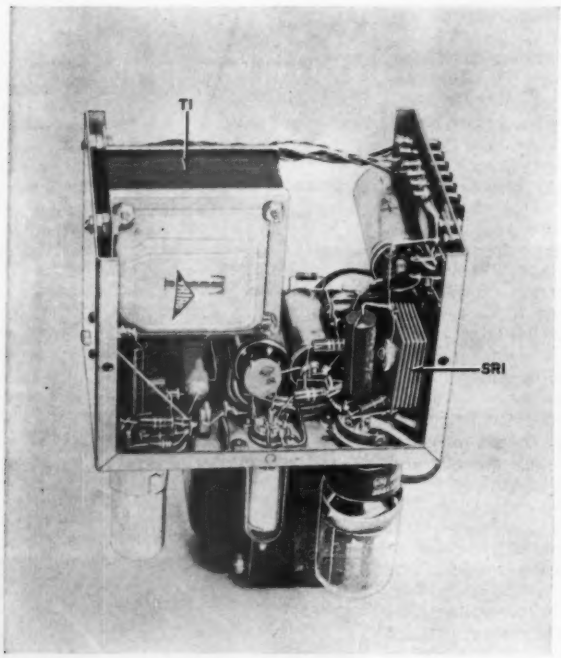
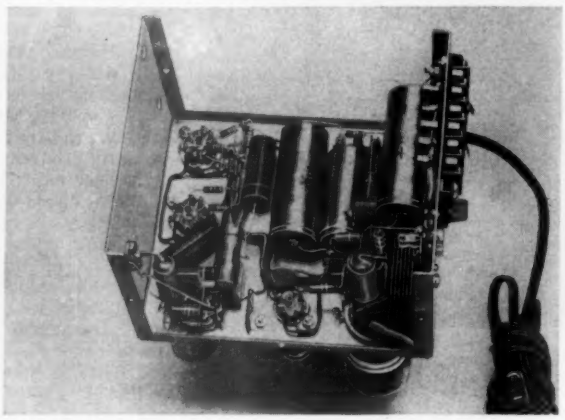


Fig. 1. Complete amplifier is built on 4" x 5" x 6" chassis box.

◀ Fig. 2. Under-side of the amplifier chassis showing components.

Fig. 3. Under-side view with output transformer not yet mounted.





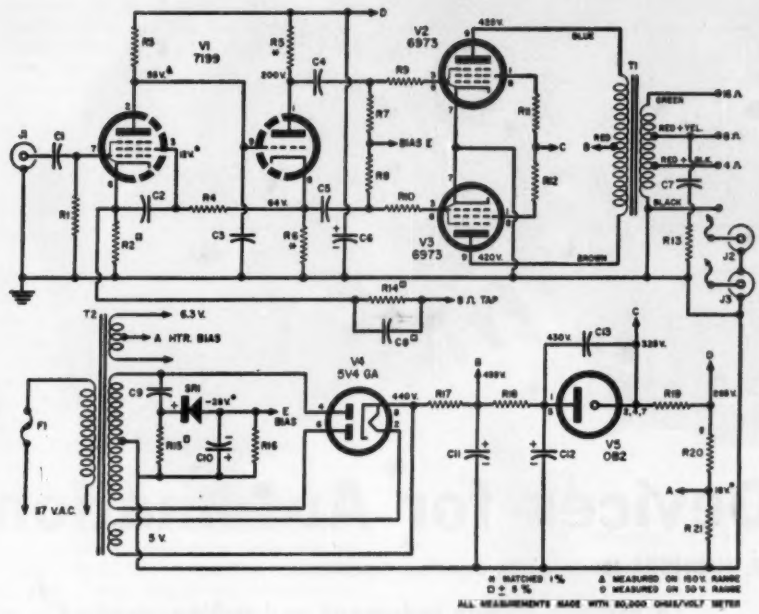
THIS article describes a compact, economical, and easily built audio power amplifier which is equally useful as the basic unit of a high-quality monophonic system or as a second amplifier for stereo conversions. The amplifier uses the recently announced *RCA* "High-Fidelity" tubes and is built complete with power supply on a 4" x 5" x 6" "Minibox" chassis. Despite its small size, it is capable of developing 20 watts with only 0.6% total harmonic distortion and 1.55% intermodulation distortion; has excellent frequency response characteristics; extremely low hum and noise; and high sensitivity.

Circuit Details

Fig. 4 is the circuit diagram and parts list for the amplifier while the photographs of Figs. 1, 2, and 3 show the layout and mechanical construction. An *RCA* 7199 medium-mu triode, sharp-cut-off pentode, which has specially controlled hum and noise characteristics, is used as a high-gain voltage amplifier and phase-splitter, driving push-pull *RCA* 6973 beam power tubes operating in class AB_1 with fixed bias.

Direct coupling between the voltage-amplifier and phase-splitter stages minimizes phase shifts and permits the use of 22 db of inverse feedback between the voice-coil terminals of the output transformer and the cathode of the input stage. This relatively large amount of feedback helps minimize distortion and hum and provides the low output impedance necessary for effective speaker damping. The output impedance at the 8-ohm voice-coil terminals is 0.8 ohm (damping factor = 10).

The voltage gain of the pentode input stage with the feedback loop open is in excess of 200. The constants of



R_1—330,000 ohm, ½ w. res.
R_3, R_{13}—1000 ohm, ½ w. res.
R_3, R_4—820,000 ohm, ½ w. res.
R_5, R_6—15,000 ohm, 1 w. res. (matched 1%).
R_7, R_8—270,000 ohm, ½ w. res.
R_9, R_{10}—470 ohm, ½ w. res.
R_{11}, R_{16}—100 ohm, ½ w. res.
R_{14}—33,000 ohm, ½ w. res.
R_{15}—5600 ohm, 1 w. res.
R_{16}—56,000 ohm, ½ w. res.
R_{17}—56 ohm, 1 w. res.
R_{18}—470 ohm, 1 w. res.
R_{19}—10,000 ohm, 1 w. res.
R_{20}—150,000 ohm, 1 w. res.
R_{21}—10,000 ohm, ½ w. res.
C_1—.05 μf., 400 v. capacitor
C_2—.5 μf., 200 v. capacitor
C_3—15 μμf. mica capacitor
C_4, C_5—.1 μf., 400 v. capacitor
C_6—20 μf., 350 v. elec. capacitor
C_7, C_{13}—.02 μf., 200 v. capacitor
C_8—82 μμf. mica capacitor
C_9—.05 μf., 600 v. capacitor
C_{10}—100 μf., 50 v. elec. capacitor
C_{11}, C_{12}—40 μf., 450 v. elec. capacitor
J_1, J_2, J_3—Phono jack
SR_1—75 ma. selenium rectifier
F_1—2 amp fuse
T_1—Output trans. 8000 ohms c.t. to 16, 8, 4 ohm v.c. (Triad S-31A)
T_2—Power trans. 350-0-350 v. @ 120 ma.; 5 v. @ 3 amps; 6.3 v. c.t. @ 4.7 amps. (Thordarson 24R03U or equiv.)
V_1—7199 tube (RCA)
V_2, V_3—6973 tube (RCA)
V_4—5V4-GA tube (RCA)
V_5—0B2 tube

Fig. 4. Circuit of the miniature high-fidelity amplifier, with typical voltages.

this stage and of the direct-coupled phase-splitter stage were carefully chosen to assure class A operation of these stages at signal levels well beyond that required for full output. Grid-No. 2 voltage for the pentode unit is obtained from the cathode of the triode unit. Because of the large time-constant of the grid No. 2 circuit (0.82 megohm x 0.5 μf.), the grid-No. 2-to-cathode potential is essentially constant for audio frequencies. This arrangement provides feedback between the two units which stabilizes the operating point of the phase-splitter against changes in the "B" supply voltage and tube characteristics.

Two networks are used to assure stability at high frequencies. The 15-μμf. capacitor connected from the plate of the pentode amplifier to ground provides a gradual roll-off in response beginning at 15 kc. The .02-μf. capacitor and the 1000-ohm resistor across the 8-ohm winding of the output transformer suppress high-frequency oscillations under overload conditions.

Power-Supply Details

The excellent performance of the amplifier is partly due to the design of the power-supply circuit. An *RCA* 5V4-GA rectifier tube is used because of its small internal voltage drop and excellent regulation. Its indirectly heated cathode also delays the build up of full "B" supply voltage until the tubes have reached operating temperature, thus minimizing voltage surges across the power-supply components. Grid-No. 2 voltage for the 6973 output tube is obtained from the plate-supply voltage through an 0B2 glow-discharge voltage-regulator tube. This arrangement provides the extremely stable grid-No. 2 voltage necessary to assure low distortion at full output and minimizes the current drain on the power transformer because it eliminates the need for power-wasting, voltage-dropping resistors or bleeder networks.

Construction

Fig. 1 is a top view of the amplifier while Figs. 2 and 3 show the underside and wiring. With the exception of the relative positions of the power and output transformers, placement of components is not critical.

No marked effect on the amplifier's stability or performance was noted despite the fact that it was built in the rather limited confines of the 4" x 5" x 6" "Minibox." The windings of the output transformer are well shielded electrostatically by the core and the transformer housing. Coupling from the magnetic field of the output transformer is not a problem because this field is of very small magnitude. To minimize undesired coupling from the plate lead of the output transformer, the transformer was mounted so that these leads come out of the case on the side farthest from the input stage.

Because of its proximity to the power transformer, the output transformer picks up a small a.c. component. The resulting hum has a level of about 100 db below 20 watts and can be reduced, if desired, by rotating the output transformer 5 to 10 degrees while observing the a.c. output of the amplifier on an oscilloscope or a high-sensitivity voltmeter.

Compact construction often engenders heat-dissipation problems. In this amplifier the principal sources of heat, *i.e.*, the tubes and power transformer, are mounted on top of the chassis so that the heat rises without detrimental effect on the components on the underside of the chassis.

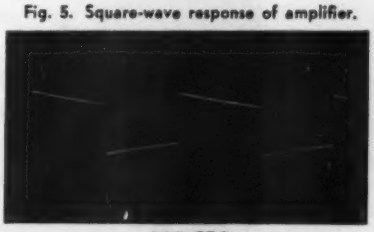
To increase the flexibility of this amplifier, two phono jacks are mounted on the rear of the chassis and connected to two spare terminals on the output-terminal strip. Any tap on the voice-coil winding can thus be connected to either jack by connecting a jumper between the appropriate binding posts.

The following suggestions will help you obtain maximum performance from this or any other audio amplifier you construct.

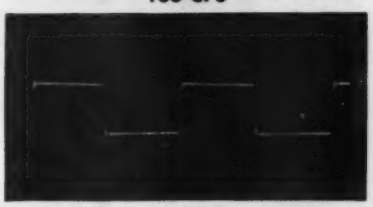
1. Dress the a.f. input lead away from the heater wiring. Hum picked up

(*Continued on page* 116)

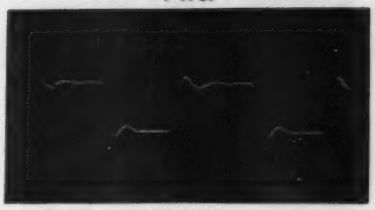
Fig. 5. Square-wave response of amplifier.



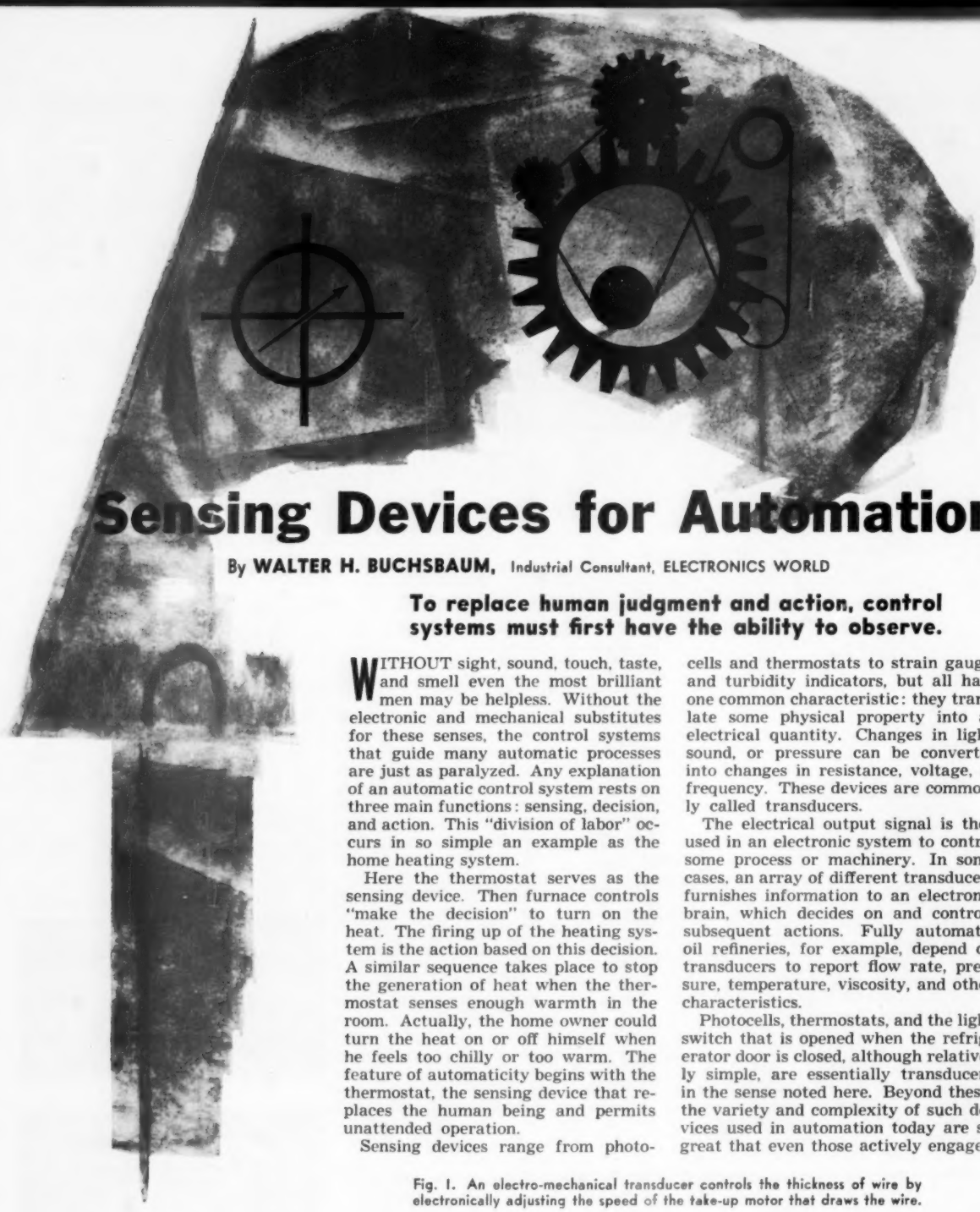
100 CPS



1 KC.



10 KC.



Sensing Devices for Automation

By **WALTER H. BUCHSBAUM,** Industrial Consultant, ELECTRONICS WORLD

To replace human judgment and action, control systems must first have the ability to observe.

WITHOUT sight, sound, touch, taste, and smell even the most brilliant men may be helpless. Without the electronic and mechanical substitutes for these senses, the control systems that guide many automatic processes are just as paralyzed. Any explanation of an automatic control system rests on three main functions: sensing, decision, and action. This "division of labor" occurs in so simple an example as the home heating system.

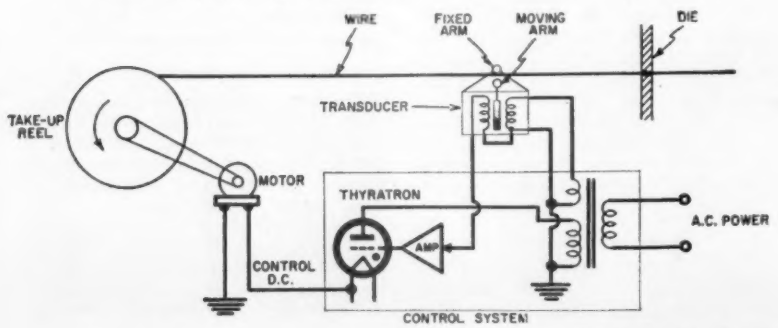
Here the thermostat serves as the sensing device. Then furnace controls "make the decision" to turn on the heat. The firing up of the heating system is the action based on this decision. A similar sequence takes place to stop the generation of heat when the thermostat senses enough warmth in the room. Actually, the home owner could turn the heat on or off himself when he feels too chilly or too warm. The feature of automaticity begins with the thermostat, the sensing device that replaces the human being and permits unattended operation.

Sensing devices range from photocells and thermostats to strain gauges and turbidity indicators, but all have one common characteristic: they translate some physical property into an electrical quantity. Changes in light, sound, or pressure can be converted into changes in resistance, voltage, or frequency. These devices are commonly called transducers.

The electrical output signal is then used in an electronic system to control some process or machinery. In some cases, an array of different transducers furnishes information to an electronic brain, which decides on and controls subsequent actions. Fully automatic oil refineries, for example, depend on transducers to report flow rate, pressure, temperature, viscosity, and other characteristics.

Photocells, thermostats, and the light switch that is opened when the refrigerator door is closed, although relatively simple, are essentially transducers in the sense noted here. Beyond these, the variety and complexity of such devices used in automation today are so great that even those actively engaged

Fig. 1. An electro-mechanical transducer controls the thickness of wire by electronically adjusting the speed of the take-up motor that draws the wire.



in industrial electronics rarely become familiar with all types. Thus we will outline some basic transducer applications, descriptions of how different types work, and some practical information on cleaning, adjusting, testing, and replacing of widely used units. Some fairly unusual types will also be noted, but very special transducers —such as those depending on nuclear, x-ray, or particle radiation—will be omitted.

Electrical forces, such as load currents in motors or transformers, can be utilized directly to activate electronic control systems, but if heat, pressure, humidity, flow, or other parameters are to be controlled, a transducer is required. Fig. 1 shows the basic functions of an automatic control system. The example is a thickness-control system used in a wire-drawing process.

Here the take-up reel furnishes the power that pulls the wire through the dies. When the wire is pulled faster, it gets stretched more and therefore is thinner. If the motor speed is constant, the actual wire speed will increase as the wire is gathered on the take-up reel. To maintain the wire at constant pulling speed, the motor must be slowed down as the wire builds up on the take-up reel. Motor speed is controlled by the d.c. voltage supplied to it. Depending on the firing point of the thyratron rectifier, more or less d.c. output will be obtained, and the firing point is controlled by the amplified signal from the transducer.

The transducer, in this case, is a pressure-differential type, which changes displacement of the moving mechanical arm into a voltage change by moving the core of a transformer. The moving arm is spring loaded and contacts the wire through a roller to reduce friction. As the arm moves up, due to a smaller wire diameter, the transformer core is withdrawn, reducing the coupling between primary and secondary. This reduces the power transferred to the secondary and therefore the voltage available to trigger the thyratron. In turn, this will reduce the motor speed. Similar systems are used in rolling mills where the thickness of metal is automatically controlled.

Another example of a pressure transducer is the one that regulates air pressure in a modern airliner cabin. The major difference is that the mechanical motion of a diaphragm is used instead of a spring-loaded plunger, but the center of the diaphragm is also linked to a movable transformer core. In place of the motor driving the take-up reel, a servo motor is used to open or close the air-outlet valve which regulates cabin pressure.

Other pressure-regulating systems include such varied applications as vacuum gauges, high-pressure gas systems, pneumatic production tools, hydraulic systems and a host of cases where any sort of gas or liquid pressure is used. Surprisingly enough, the same type of pressure transducer can be found in the liquid-oxygen system of a missile and in the carbonating pipes of a soft-drink bottling plant. The main differences among various types of pressure transducers are in their range, temperature, vibration and shock stability, and their electrical characteristics.

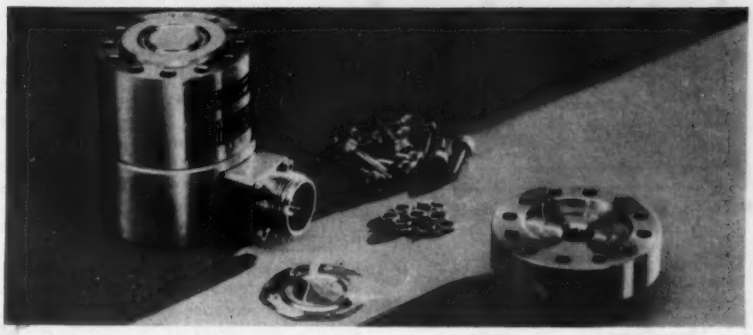


Fig. 2. Taber transducer with removable pressure section to simplify cleaning.

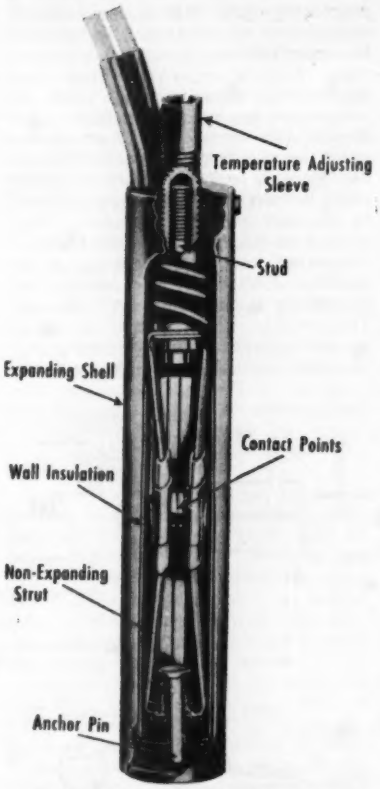
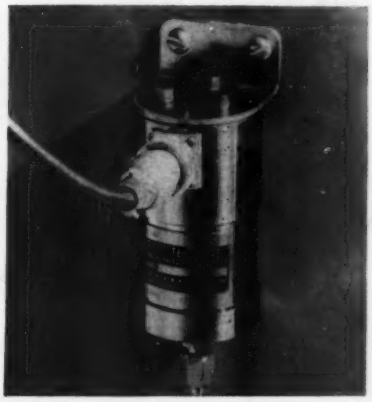


Fig. 3. Industrial thermostats are more rugged than the home heating types.

Fig. 4. A bonded strain gauge by Taber.



How Transducers Work

Transducers must be sensitive to their particular physical property or action, but insensitive to others. The pressure transducer, for example, should indicate pressure accurately—irrespective of temperature, vibration, or humidity. Similarly, temperature transducers should be impervious to other influences.

In industrial electronic applications the thermostat is often subject to vibration, shock, or other forces that the simple bi-metallic home unit may not be able to take. While there are a host of rugged and reliable thermostatic switches on the market, we have selected the *Fenwal* "Thermoswitch," shown in Fig. 3, to illustrate the difference between the familiar home appliance and an industrial type.

The outer shell, made of brass, expands with increasing temperature. This expansion pulls apart the non-expanding struts (made of Invar), separating the insulated contact points. Adjustment of the exact temperature switching point, of interest to the service-minded reader, is accomplished by rotating the threaded sleeve at the top of the unit.

In addition to this type of switch there are a host of others, including thermistors, used for temperature sensing. Students of basic radio are familiar with changes in resistance that occur with changes in temperature. A thermistor is simply a resistor with a predictable temperature characteristic.

To sense humidity electrically, one could allow the tank circuit of an oscillator to drift as the humidity changes. Actually, some humidity sensing devices operate on this basis, but most depend on the change in resistance of a moisture-sensitive film, usually measured by a Wheatstone bridge.

Resistance-type transducers are frequently connected in bridge circuits because even slight unbalance can easily be detected. Typical of these are the strain gauges shown in Figs. 5 and 6. In the first, two opposite arms of the

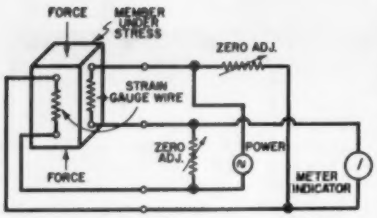


Fig. 5. Bonded strain gauge in Wheatstone bridge with meter as indicator.

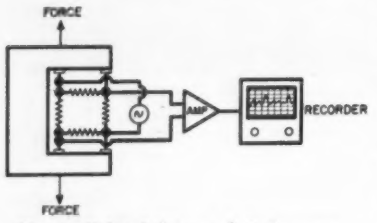


Fig. 6. Unbonded type of strain gauge with a recorder as output indicator.

Wheatstone bridge network are bonded directly to the structural member whose stress or strain is being measured. The strain-gauge elements are made of fine wire that changes its resistance as it is stretched or compressed. These changes are very small but, because they occur in opposite arms of the bridge, their effect is much more noticeable. As shown in Fig. 5, the bridge is adjusted to zero the meter reading before the stress is applied.

In Fig. 6 we show an unbonded type of strain gauge, where all four arms of the bridge form a free grid with opposite arms under tension. This type is used in permanent weighing systems where a small expansion of a calibrated stress member is measured. The bonded type of strain gauge is used mostly for continuous measurements and tests, of a single member, but can also be found as part of a separate pressure transducer, such as the "Teledyne" Model 217 shown in Fig. 4. Here gas or air pressure deflects a diaphragm that presses on a ring to which strain-gauge elements are bonded.

A basic resistance-type transducer is shown in the simplified diagram of Fig. 7A. Here pressure moves a diaphragm linked to the arm of a potentiometer. The control circuit for this kind of transducer might be an amplifier whose plate current passes through the control winding of a saturable reactor. In this way, the resistance of the transducer controls the a.c. voltage delivered to the rectifier, and thence to the motor.

Next to the resistor type of pressure transducer, the inductive types are probably the most widely used. They range from a simple tuning-slug motion inside a coil to the linear differential transformer types. There are many different winding arrangements, but the principle of a differential transformer can be seen in Fig. 7B. Pressure on the diaphragm moves the core, changing the flux linkage between the primary and the two secondaries in such a way that one of the two triodes receives a larger grid signal than the other. The difference is amplified and can be measured by a meter connected between the plates or amplified further and used as error voltage for a servo positioning system. By proper arrangement of the voltages it is possible to obtain a difference in phase as well as amplitude, and thereby indicate the direction of diaphragm motion.

The change in capacitance as the distance between capacitor plates is changed is the principle used in the capacitive transducer (Fig. 8A). Although a compressible dielectric is shown, this could simply be air. The housing is part of the grounded outer plate, which may be in the form of a diaphragm, and the inner plate is mounted on an insulator. To increase the capacitive change, both plates sometimes contain concentric rings and grooves that mesh into each other. In control systems using capacitive transducers, the control element includes either an oscillator or a tuned amplifier. Here an oscillator is shown, which could be part of a telemetering system to transmit pressure changes as frequency modulation of a carrier signal.

Another look at Fig. 8A raises the question: "Why can't we tune the coil by moving a slug inside it?" We can. This widely used method is incorporated in the transducer shown in Fig. 11 which contains a single, variable-reluctance, tuning coil. Depending on the external circuit, this coil can resonate anywhere from 400 cps to 7 kc., and will produce a ±7.5 per-cent frequency change for a pressure change of up to 5000 psi (pounds per square inch).

In addition to the basic resistive, capacitive, and inductive pressure transducers, there are a few special types such as the magnetostrictive, electrokinetic, and piezoelectric. The first of these works on the principle that a physical distortion of certain nickel alloys causes changes in their magnetic properties. The second depends on the flow of a polar fluid (an electrically charged fluid, such as an electrolyte) through a porous membrane, which generates a potential across this membrane. The third type will be more familiar since, in a way, it is used in many phonographs and microphones. When a crystalline structure is distorted physically, it generates a small voltage in proportion to the distorting force, as occurs in phono cartridges or microphones using crystal or ceramic elements. This property is harnessed differently in the accelerometer circuit of Fig. 8B.

If we think of the base of the crystal as part of a missile that is moving toward the top of the page, then the force acting on the small load plate at the top of the crystal is the acceleration

(*Continued on page* 130)

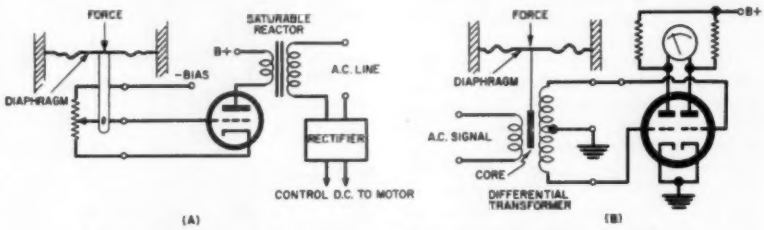


Fig. 7. In resistance type of transducer (A) pressure moves arm of potentiometer. In inductive transducer (B) pressure moves core of a transformer.

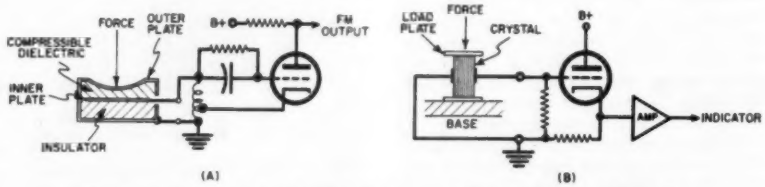
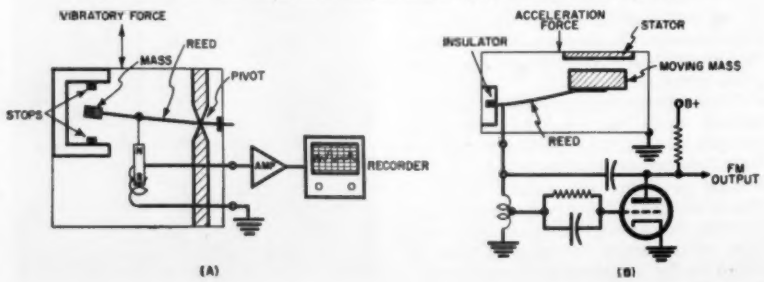


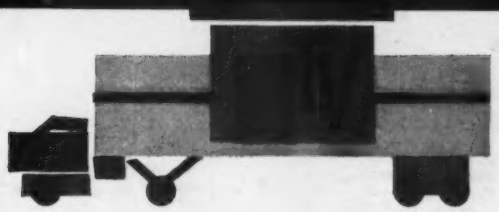
Fig. 8. A capacitive transducer (A) can translate a force into a change in oscillator frequency. A piezoelectric transducer (B) yields a voltage output.

Fig. 9. In an inductive vibration transducer (A), a magnet induces a voltage in a coil. The capacitive accelerometer (B) is related to Fig. 8A.



By **ERNEST W. FAIR**

Check carefully to make sure that the new pasture is indeed a greener one.



SHOULD YOU MOVE YOUR SHOP?

HAVE YOU found what looks like a much better location for your electronic service business than your present spot? Or do things look so good there that plans are afoot for a second shop, while you keep the present one? That greener pasture may indeed offer far greater opportunity, but don't be so eager that you may skip over drawbacks. Before you take action, take off the rose-colored glasses and have a sober look. Many an enthusiastic shop owner has made a hopeful move only to learn that he gave up a better location than the one he acquired.

Important factors that should be evaluated when a move is contemplated are listed here, in the form of questions. Most of them will apply in most cases. To help yourself decide, you might draw up a Business Move Check Chart, consisting of three columns. In the first column, put the numbers of the factors. The second and third columns are labeled "Yes" and "No" respectively. You then place a check in either of these columns beside each factor, depending upon whether your answer to the question does or does not favor the move. If either one column or the other dominates the answers, you may get a better picture of your prospects than you would get from an ill-defined guess colored either by over-optimism or timidity.

1. Is the present market for electronic service any better in the new location than in the old one? Too often, plans are made with heavy reliance on future prospects. However, the present situation must get some consideration. To begin with, future projections may not turn out as good as anticipated. In addition, the sacrifice of even an average market in the existing location for a poor initial market in the new place may prove a serious financial drain on your resources, which you had better be prepared to meet. In any move, the present potential market at the contemplated spot should preferably look at least as good as the old one.

2. Will land rental, building lease, or purchase costs be at least as low as for the present shop? Where *current* conditions in the new place promise to be exceptionally good—that is, noticeably better than conditions for the old shop—some increase in these costs may be justified. Otherwise be careful about biting off more than you can chew.

3. Will operating overhead in general be close to the figures you are used to assimilating? No matter how rosy the picture, high overhead can cancel out all your extra profit. If the contemplated location is some distance away, make sure you take into account possible differences in utility costs. Climate can also be a factor. High heating costs, for example, can be important if you must provide your own heat.

4. Are sources of supply as convenient and close at hand, or more convenient, as they are now? Where you are considering an outlying area, from which it will be difficult to obtain stock quickly, you will have to tie up additional capital in a larger inventory. A marked increase in shipping costs over the year can also make a difference that should not be overlooked. You may also have to pay higher prices for supplies.

5. If your shop is larger than a one-man operation, will the wages you must pay be no higher than you have been paying, and are there technicians available for employment? Particularly if your venture is successful, this will be a factor.

6. If competitive shops are located in the new area, are they operating profitably? If they are not, there may be factors at work in the contemplated location that make it undesirable, even if you have not been able to isolate them. And you may have no more success in overcoming them than anyone else.

7. Is the idea of moving into this new, promising territory just your own, or do you know of other shop owners toying with the same notion? If the idea is your own, a check belongs in the "Yes" column. If others are planning the same move, any advantage you now see in bidding for the local business may well be wiped out.

8. Can you make the move at a reasonable cost? It takes a long time to make back, out of profits, the high cost of moving a business. Moving costs have been the cause of failure of more than one business.

9. Are there new opportunities for service in the area not present where you are now located? Perhaps there are business establishments or other institutions in the new area that require local service for work on two-way mobile radio, intercoms, or p.a. systems. There may be motels with TV signal distribution systems. Any new opportunities that did not exist before are promising.

10. Is your present background sufficient for handling new types of service and new problems? Opportunities will mean nothing if you are in no position to take advantage of them.

11. Are there good trade or professional organizations and associations in the new area, or will you be on your own? If you have been a member of such an organization, you don't have to be told the advantages it offers. Even where you are not a member, the existence of such a group in an area can make a big difference in the general business climate.

12. Do you have enough capital to finance the changeover without borrowing? If you don't, add the difficulty of repaying out of earnings to the other problems of financial adjustment you will have while getting your business settled all over again.

13. Is the new location near enough to the old one so that you can still service at least some of your present customers from there? This is important. You may not be able to keep all your old customers, but holding on to many can help you through an adjustment period. If you are moving too far away, don't underestimate the length of time it will take to build up an adequate number of customers in the new market.

14. Are customers in the contemplated area "educated" to expect courtesy services no greater than those you are accustomed to providing? If they are used to having tubes tested free, free bench checks, discounts, and the like, and you did not have to meet such conditions until now, think twice. Every one of these services costs money. Be sure to figure them into the costs of doing business. The general standards of doing business in your area, as well as those pertaining strictly to service, should also be taken into account here.

15. Does the market in the new location favor a business of your *size?* In some areas people may show a preference for dealing only with larger establishments. In other places, people may favor the intimate relationship possible with a smaller business. If the contemplated size of your shop does not fit into the pattern, your chances of survival are reduced.

16. Is there an absence of service shops maintained or sponsored by retail dealers or manufacturers? If so, you have a decided advantage. You may even be in a position to bid for such authorized or contract service yourself.

17. Is the area in a state of *solid*

(*Continued on page* 112)

R_3—6800 ohm, ½ w. res.
R_5—10,000 ohm, 1 w. res.
R_4, R_6, R_7—1 megohm, ½ w. res.
R_8—4700 ohm. 1 w. res.
R_9—4.7 megohm, ½ w. res.
R_{10}—2200 ohm, 2 w. res.
C_1—75 μμf. var. capacitor (E. F. Johnson 149-5, 100R12 with three plates removed, see text)
C_2—10 μμf. var. capacitor (E. F. Johnson 157-1, 7J12)
C_3—50 μμf. mica or disc capacitor
C_4—.001 μf. mica or disc capacitor
C_5—.02 μf. paper capacitor
C_6-C_7—40/40 μf., 200 v. elec. capacitor
L_1, L_2—See coil details at right
S_1—S.p.s.t. toggle switch
T_1—Power trans. 117 v. @ 15 ma.; 6.3 v. @ 0.6 amp. (Triad R-54X)
V_1—12AU7 tube
V_2—6E5 tube
1—24" length of 72-ohm twin-lead

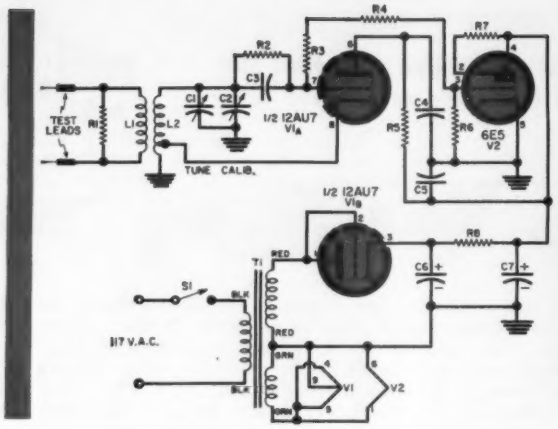


Fig. 1. Schematic of the solver and, to the right, detail for coil winding.

The Capacitance Solver

By **DONALD L. STONER, W6TNS**

Build this simple, direct-reading instrument to determine correct value of unknown capacitors.

IT HAS been said that color codes were devised to confuse the competition. The variety of tubular and mica capacitor color codes, introduced over the years, would tend to confirm this. If the reader has an assortment of capacitors, dating back a few years, he may find as many as a dozen variations of the basic color code.

Particularly baffling are the tiny tubular ceramic types that are usually found in r.f. circuits. Many of these have only one or two color bands (or paint dots) to indicate the value. Of course, a capacitor checker would solve many of these miniature mysteries, but most instruments have a minimum reading of 10 μμf. on the lowest scale.

A device to "take you away from all this" is shown in Figs. 1 & 2. It will indicate, with good accuracy, values of capacity between 0 and 50 μμf. Basically, it is an oscillator circuit, commonly called a grid-dip meter, which is coupled to a tuned circuit (L_1). The tuned circuit acts as a reference resonant frequency. The coil for this circuit is located near the oscillator coil (L_2), and the associated capacitor for L_1 consists of a length of 72-ohm twin-lead.

The unknown capacitor is connected in parallel with the reference tuned circuit (at the end of the twin-lead), which lowers the resonant frequency. The oscillating frequency of the grid-dipper is controlled by the front panel knob (C_1), which is calibrated in micromicrofarads rather than megacycles. Whenever the oscillator and the reference circuit are on the same frequency, energy is absorbed from the oscillator, which causes a reduction in oscillator grid current. The "magic eye" tube is

(*Continued on page* 78)

Fig. 2. The completed unit is compact and easy to use. The tuning control operates capacitor C_1; the calibrating knob connects to capacitor C_2.

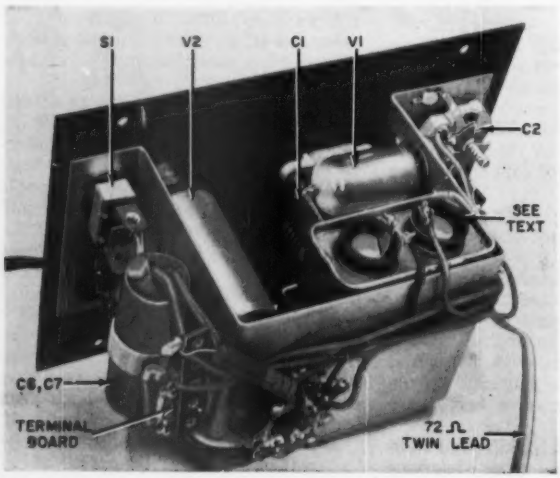
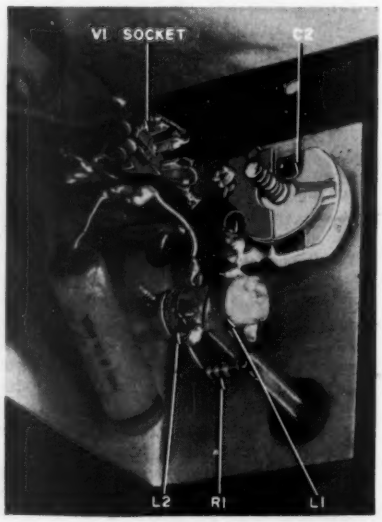
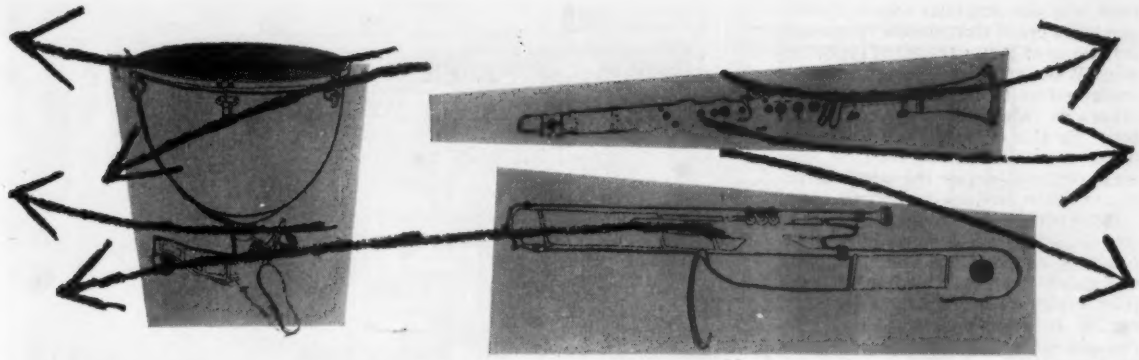


Fig. 3. (Left) Rear view of chassis out of case shows location of most important components except for coils at input. Capacitor marked "see text" was used in early version, is replaced by power transformer.

Fig. 4. (Right) Detail of right, rear side of chassis shows layout of coils at input and other front-end components.





Bass-Treble Hi-Fi Amplifier

By FRANK R. BARKEY

Complete construction details on a power amplifier that delivers about 20 watts of bass power and 20 watts of treble power to separate speaker systems.

THE possibilities for improved reproduction through the use of two channels seem to have been neglected. Comparatively few double-channel amplifiers are on the market today for home use. There are, of course, those who use two amplifiers to feed separate speakers but even these are relatively few and their main interest is with stereophonic reproduction.

The potential ability of two channels to give better transient reproduction, lower harmonic and intermodulation distortion, cleaner bass and greater tonal separation has been overlooked seemingly because of several faults which are not impossible of correction. The question of cost does not seem a factor since the outlay for an additional output transformer and several tubes is balanced by a simpler preamplifier and elimination of the speaker crossover. Less expensive output transformers may give good results.

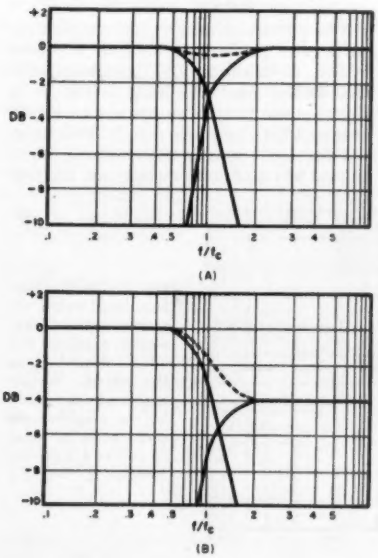
Two difficulties arise in the use of twin amplifiers or twin channels. They result, in part, from the fact that a good amplifier is designed for flat, wide-band response and partly from the necessary use of an electronic crossover. The first difficulty shows up when we analyze the combined output from two channels. Fig. 1A shows the type of response curve usually associated with this type of operation There is flat bass response with sharp roll-off at the crossover frequency. Similarly the treble response is flat with an equally abrupt roll-off. The combined response is excellent until we change the setting of the gain control in either channel. Such change creates a sharp step in the over-all response, either up or down, at the crossover frequency, as shown in Fig. 1B.

The second difficulty is the large amount of phase shift occurring at the crossover network. It is usual to use two, sometimes three, *RC* stages in each leg to secure the desired roll-off.

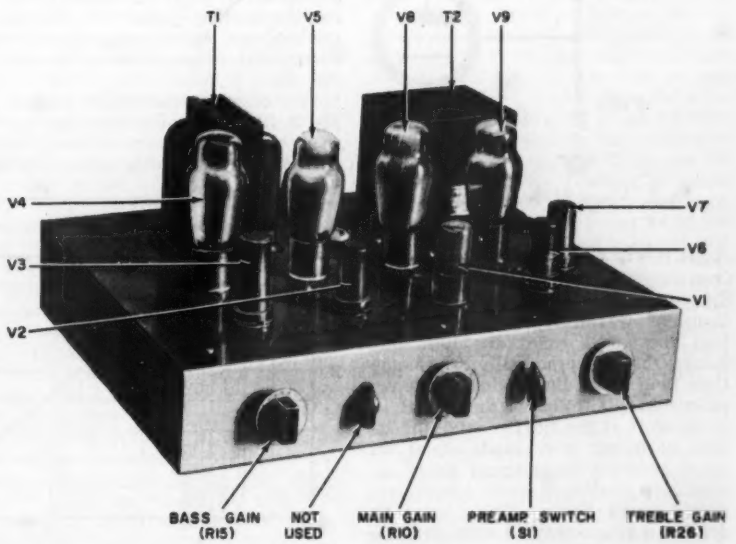
The solution to these two problems provides an opportunity for improved reproduction which is not possible with single-channel amplifiers, nor indeed with twin amplifiers.

Good frequency response doesn't necessarily mean good transient reproduction any more than good frequency response means high-quality reproduction. Most single-channel amplifiers, and twin-amplifier arrangements, cause distortion of transients to a greater or lesser degree. The main reason, per-

Fig. 1. Usual two-channel output curves with (A) similar and (B) different gains.



Over-all view of two-channel amplifier showing location of controls and tubes. The bass portion of the amplifier is on the left, the treble is on the right.



haps, why one amplifier sounds cleaner and has more of that elusive "presence" is because of better transient reproduction. When speaking of transients this writer refers to any sound, musical or otherwise, which is not a continuous tone. By this definition the piano produces transient sounds only, in contrast to the violin or the wind instruments which produce continuous tones.

Good transient reproduction is not as simple as the reproduction of continuous-state sounds. The audible quality of a steady tone doesn't suffer too much from moderate degrees of phase shift, nor is it objectionably degraded by changes in the phase relationship of its component frequencies. About the worst that can be expected is a change in timbre. Transients, on the other hand, are greatly affected by phase changes. A transient waveform is complicated. Its component frequencies may be unrelated harmonically and spaced widely. The shape of the waveform, and hence its sound, is delicately dependent on the phase relationship of the component frequencies. Any change in this relationship alters the transient waveform and it may sound different.

To illustrate how easily this occurs, let us assume a transient containing frequencies of 50, 500, and 5000 cycles per second. Across a simple coupling circuit such as Fig. 2, phase shift can be expressed: $\tan \phi = \frac{1}{\omega CR}$

At 50 cycles: $\tan \phi = \frac{1}{\omega CR}$

$$= \frac{1}{2\pi \times 50 \times .05 \times 10^{-6} \times .5 \times 10^{6}}$$

$$= \frac{1}{\pi \times 2.5}$$

$= 7°$ of phase shift.

Over three similar circuits in the average amplifier this totals 21° of phase shift at 50 cycles. At 500 cycles the total will equal roughly 1°. At 5000

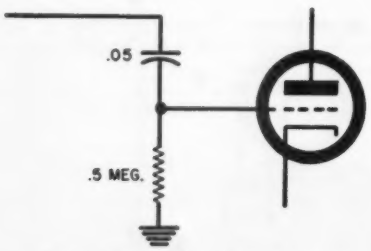
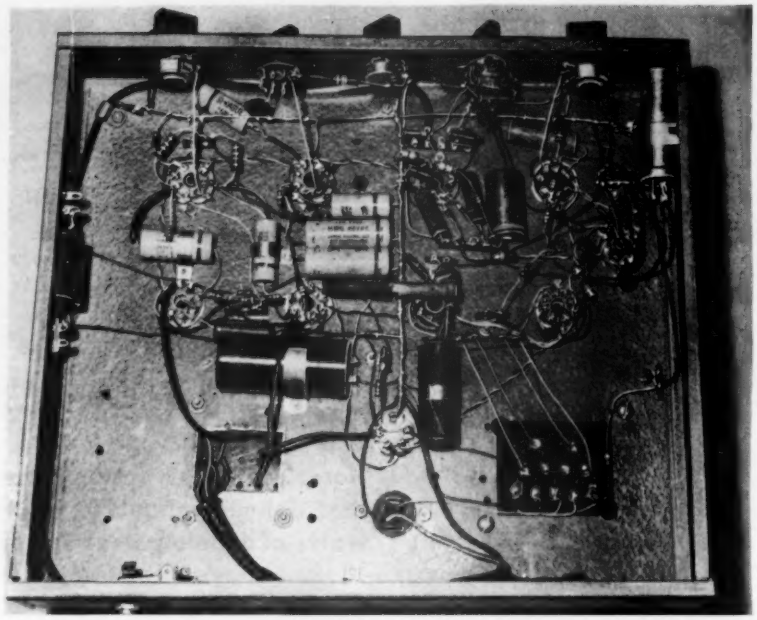


Fig. 2. Simple RC coupling circuit.

cycles it is 0° for all practical purposes. Oversimplified as this is it can be seen that we have altered the shape of the transient waveform. Note, however, that above 500 cycles, the 10th harmonic, there is practically no change (less than 1°) in the original phase relationship. It follows, then, that if phase shift at the fundamental and its 10th harmonic were made equal we could preserve the original phase relationship at all component frequencies within small limits. This cannot be done in a single-channel amplifier, nor



Underside of chassis. A heavy ground bus, supported on insulated tie points, runs through the center of the chassis and across the front. It is grounded to the chassis at only one point near the input. Between the output transformers is the power socket, below which is a rubber-lined opening to the output terminal strip.

in a twin-amplifier arrangement, except by using impractically large values of C in the coupling circuits. We can, however, design one channel to reproduce low frequencies with minimum phase shift and a second channel which will duplicate this shift at the 10th harmonic. In other words, low-channel phase shift at 100 cycles will equal high-channel shift at 1000 cycles.

The problem of large over-all phase shift at the crossover network can be minimized by using a single-stage network. Moderate degrees of shift will not affect the sound of the transient *providing* we maintain the phase relationship of the component frequencies. A single-stage crossover can be designed which will: (1) equalize high- and low-channel phase shift, (2) alter the response curves to eliminate frequency distortion caused by the step of Fig 1B.

Two response curves are shown in Fig. 3. The bass curve has a constantly rising response at approximately 6 db per octave. The treble curve has flat response with a slow roll-off at the low-frequency end. If these were the characteristics of two channels, changing the setting of the gain controls would shift these curves up or down in relation to each other, but at no usable crossover frequency would we obtain the configuration of Fig. 1B. The gain controls would do three things: (1) adjust the balance of highs and lows, (2) set the crossover frequency, and (3) provide continuous control of the crossover frequency. With the amount of bass boost indicated there would be little need for boost in the preamplifier which might even be a simple voltage amplifier, without compensation.

Circuit Used

The circuit of an amplifier which incorporates these specifications is shown in Fig. 4. A simple 6SL7 preamp with a switched feedback loop is fed to a single-stage crossover network. Other preamplifiers may be used, of course, but for best results with most LP's it should be possible to switch out the fre-

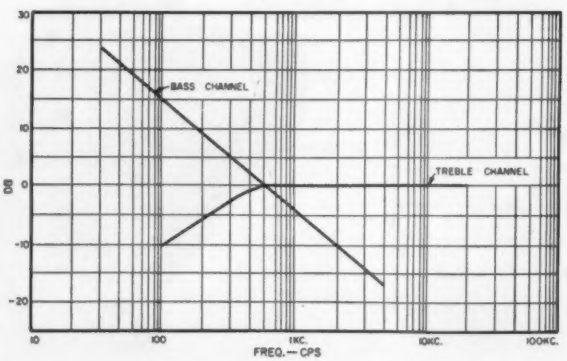


Fig. 3. The idealized bass and treble response curves that would produce the effects described by the author. The actual curves produced by the amplifier are quite close to these idealized curves. (Refer to Fig. 5.)

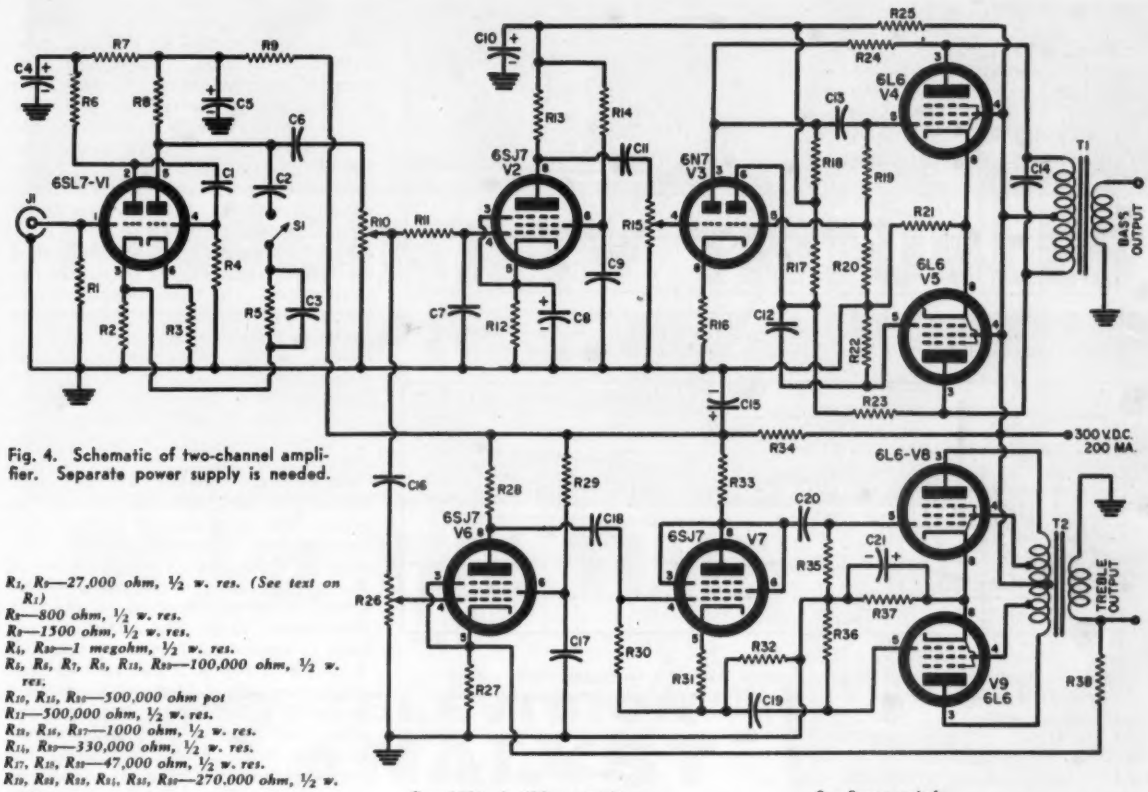


Fig. 4. Schematic of two-channel amplifier. Separate power supply is needed.

R_1, R_9—27,000 ohm, ½ w. res. (See text on R_1)
R_2—800 ohm, ½ w. res.
R_3—1500 ohm, ½ w. res.
R_4, R_{29}—1 megohm, ½ w. res.
R_5, R_6, R_7, R_8, R_{13}, R_{28}—100,000 ohm, ½ w. res.
R_{10}, R_{11}, R_{16}—500,000 ohm pot
R_{12}—500,000 ohm, ½ w. res.
R_{23}, R_{24}, R_{27}—1000 ohm, ½ w. res.
R_{14}, R_{15}—330,000 ohm, ½ w. res.
R_{17}, R_{18}, R_{19}—47,000 ohm, ½ w. res.
R_{19}, R_{20}, R_{21}, R_{31}, R_{32}—270,000 ohm, ½ w. res.
R_{22}—21,000 ohm, ½ w. res.
R_{31}, R_{37}—250 ohm, 10 w. wirewound res.
R_{33}, R_{35}—10,000 ohm, ½ w. res.
R_{37}—2700 ohm, ½ w. res.
R_{25}—31,000 ohm, ½ w. res.
R_{26}—See text
C_1, C_{11}—.05 μf., 400 v. capacitor
C_2—.002 μf., 400 v. capacitor
C_3—.0004 μf., 400 v. capacitor
C_4, C_5, C_{10}, C_{12}—20 μf., 400 v. elec. capacitor
C_6, C_9, C_{11}, C_{13}, C_{15}, C_{17}—.1 μf., 400 v. capacitor
C_7, C_{16}, C_{18}, C_{19}—.01 μf., 400 v. capacitor
C_8—100 μf., 15 v. elec. capacitor
C_{14}—.001 μf., 400 v. capacitor
C_{21}—20 μf., 30 v. elec. capacitor
J_1—Phono jack
S_1—S.p.s.t. switch
T_1, T_2—5000 ohms plate-to-plate to voice coil, 20 watts or more (Author used 6600-ohm "Ultra-Linear" type transformer for T_2, see text)
V_1—6SL7 tube
V_2, V_6, V_7—6SJ7 tube
V_3—6N7 tube
V_4, V_5, V_8, V_9—6L6 tube

quency-compensating networks. The feedback loop shown is used mainly to correct old 78's and reduce surface noise. Fig. 5 shows the response of each amplifier channel. Bass response rises steadily to a maximum of 28 db of boost at 40 cycles (with respect to a reference frequency of 1000 cycles) then rolls off to 24 db at 20 cycles. The treble channel falls off slowly below 500 cycles and is flat ± 1.5 db from 500 cycles to 100 kc. (See Fig. 6)

Neglecting the preamp for the moment, let us assume any fundamental and its 10th harmonic, say 100 cycles and 1000 cycles. Across R_{11}-C_7, the bass side of the crossover, phase shift will be expressed:

$$\tan \phi \quad \frac{1}{\omega CR}$$

$$= \frac{1}{2\pi \times 100 \times .01 \times 10^{-6} \times .5 \times 10^{6}}$$

$$= \frac{1}{\pi}$$

= 17° of phase shift.

Across the bass channel coupling circuits there will be an additional 6° of shift for a total of 23° at the grids of the output stage.

Across R_{28}-C_{18}, the treble side, at 1000 cycles:

$$\tan \phi \quad \frac{1}{\omega CR}$$

$$= \frac{1}{2\pi \times 10^{3} \times .001 \times 10^{-6} \times .5 \times 10^{6}}$$

$$= \frac{1}{\pi}$$

= 17° of phase shift.

Across the treble-channel coupling circuits there will be an additional 5° of shift for a total of 22° at the grids of the output stage. The difference of 1° over-all is small enough to be neglected. Although these calculations are oversimplified they seem to work out in practice. Oscilloscope measurements across the voice coils of both channels reveal that phase shift at the bass channel fundamental and at the 10th harmonic in the treble channel are the same within very narrow limits. Since this is so, the transient waveform, or any waveform for that matter, is reproduced with greater fidelity.

Examination of the method used to compensate the recording curve is interesting. The RIAA curve is, at the low end, flat to 500 cycles then rolls off at 6 db per octave to −20 db at 50 cycles. Fig. 5 shows that with a crossover frequency at 500 cycles there is almost exactly 20 db of boost at 50 cycles. We therefore can feed an uncompensated signal to the bass channel for a flat output. At the high-frequency end, the RIAA curve is flat to 2120 cycles then rises at 6 db per octave. At 10,000 cycles it is up 13 db. At normal listening levels this is just the boost required to conform to Fletcher-Munson listening curves. This, of course, is an argumentative point. Individual hearing ability progressively deteriorates with age. Not only is there likely to be a general loss of acuity over the entire frequency range but the ability to hear high-frequency sounds continuously decreases as age advances. For example, representative values of the falling off in ear sensitivity with age, at 4000 cycles, (compared to age 25) are: age 35, 10 db; age 45, 12 db; age 55, 24 db. (*Jensen* Technical Monograph #1, 1944). On the average, however, the 13 db of boost at 10,000 cycles seems to work out satisfactorily for most age groups.

The bass and treble response curves permit useful crossover frequencies from about 150 cycles to 2000 cycles. Setting the correct crossover frequency is not the problem it might appear at first glance. Repeated tests by the writer in setting the crossover point by ear show an average error of ± 20 cycles. The writer, a motion picture technician for over 20 years, happens to have a sensitive and trained ear. For the average listener this degree of accuracy is not probable. However, that

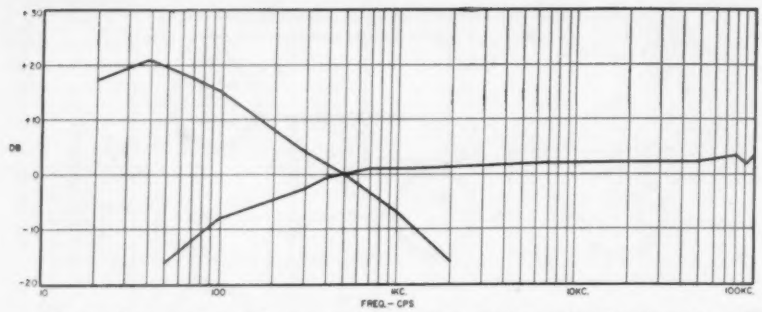


Fig. 5. Response measured across loudspeaker voice coils for each of the channels. Under these conditions the effects of speaker and enclosure resonances are included.

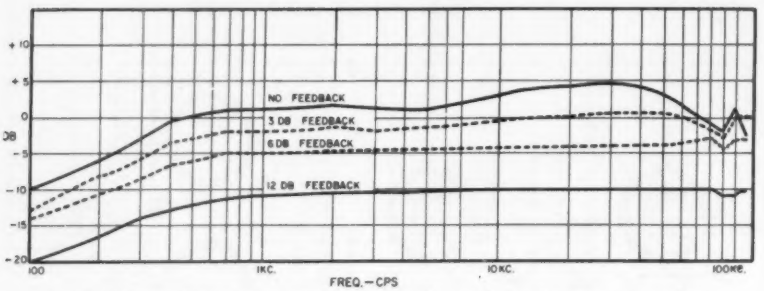


Fig. 6. Measured frequency response across the treble loudspeaker with various amounts of negative feedback employed. "Ultra-liner" type connection was used.

isn't the point. What is important is the fact that the listener can obtain a balance most pleasing to his own ears. There is a simple method of doing this. Begin with a recording whose characteristics are unknown and start with both gain controls turned off. Advance the bass control until a comfortable level is obtained. The effect is that of listening through a heavy door. Then simply open the door to the recording studio, advancing the treble control until it sounds as though you, the listener, were in the studio.

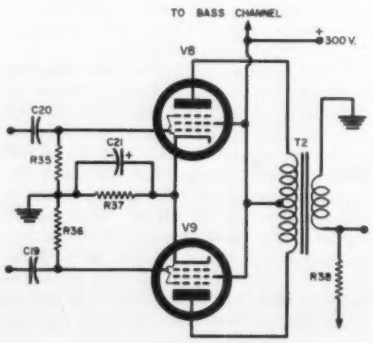
One characteristic of the bass channel is of note in the light of Howard F. Hume's experiments in stereo sound reproduction. (*Audio*, March 1957.) In his experiment #7 he found that the human head is so shaped that it appears to strip harmonics from fundamentals below 800 cycles without affecting the amplitude. The head would seem to act as a type of filter and this may be the reason why distortion is usually less noticeable at low frequencies. In our bass channel, at 70 cycles square waves approach sine-wave shape and square waves above 100 cycles are reproduced as sine waves. As a consequence the amplifier has exceptional bass quality. The pedal line of an organ, for example, is remarkably clean and pure toned.

Since there are few harmonics reproduced in the bass channel, harmonic distortion becomes much less of a problem than it is with single-channel amplifiers. Also, intermodulation products are greatly reduced since large amplitude bass frequencies are completely separated from the higher frequencies. Although no distortion measurements were made, total distortion appears to be less than that caused by the phono pickup that was utilized.

Construction

Points to be considered in construction are not complicated beyond normal care in layout and wiring to minimize hum and obtain optimum balance. From the photographs it will be noted that components are given plenty of room and that wiring has been kept to a minimum. Point-to-point technique, favored in television circuits, has been used as much as possible. This helps to reduce stray capacities and aids stability at high frequencies. The value of R_1 will vary and should be the value recommended for the pickup used. Load resistors in the bass-channel phase-inverter stage should be matched and also the grid resistors of both push-pull output stages. Signal voltages at the output grids should be balanced using v.t.v.m. or oscilloscope. Any unbalance on the bass side can be corrected by changing the value of R_{30} and with the values shown for R_{31}, R_{32}, and R_{33} there should be no unbalance on the treble side. Use of different phase-inverter stages was based on two points: keeping the treble channel as simple as possible and avoiding the hum problem of a high-potential cathode in the bass side. Since hum is not reproduced on the treble side, the high-potential cathode of the inverter stage is not a problem.

Fig. 7. Treble output circuit converted to straight tetrode connection.



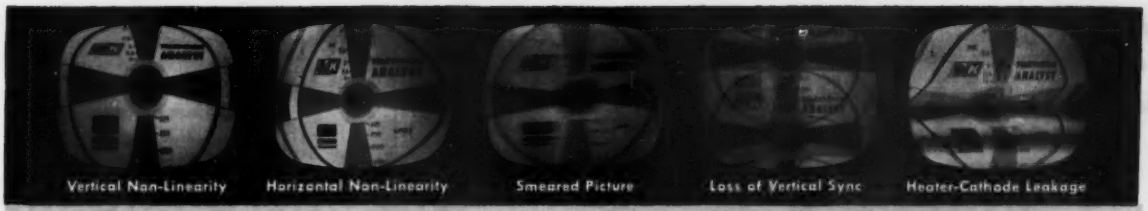
Feedback in the bass channel is used around one stage only to obtain the desired slope in the bass response curve In the treble channel the value of the feedback resistor will depend, to some extent, on the characteristics of the output transformer used. The author uses an "Ultra-Linear" unit with primary impedance 6600 ohms; primary inductance 50 henrys; leakage inductance 20 millihenrys. The advantages of "Ultra-Linear" operation for the higher frequencies only, however, are not too great. Use of a normal tetrode connection, Fig. 7, will give excellent results at lower cost. Various values of R_{29} give feedback as follows: 330,000 ohms—3 db; 16,000 ohms—6 db; and 3900 ohms—12 db. The effect of feedback in improving frequency response is shown in Fig. 6. It can be seen that more than 6 db of feedback is not warranted. If more feedback is desired, the slight reduction in distortion percentage has to be balanced against the resultant loss of gain. More than 12 db of feedback will require the addition of a push-pull driver stage after the phase inverter. Maximum power output of each channel is approximately 20 watts giving a total power output of 40 watts.

Power Supply

A ground bus, grounded at one point only on the chassis, is strongly recommended and the power supply should be constructed on a separate chassis. This will reduce the possibility of ground loops through the chassis and reduce hum to a minimum. The power supply should be capable of providing 300 volts at a minimum of 200 milliamperes. Under quiescent conditions total current drain is approximately 180 milliamperes. A center-tapped filament transformer (6.3v. @ 6a.) is recommended with the tap grounded. Either capacitor or choke input may be used.

Although the amplifier itself is perfectly stable, some instability at low frequencies may occur if the preamp is fed from a common voltage supply. If this occurs it may be necessary to use a separate supply.

Since construction of the first model of this amplifier our house has become a rendezvous for musicians, technicians, and at least one radio and TV program director, who come carrying their latest LP's for appraisal. One of them, a clarinet player, arrived on my doorstep first thing Christmas morning lugging six albums which had found their way down his chimney during the night. Critical listening tests over some months by this group have shown that the points outlined are well worth consideration. -30-



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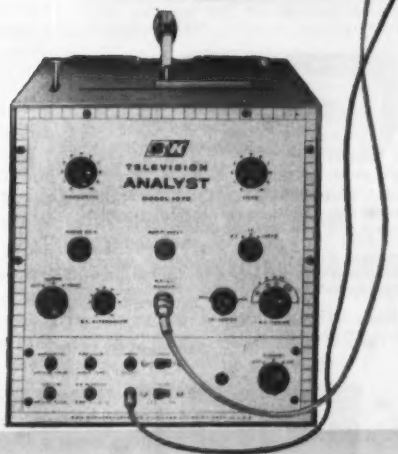

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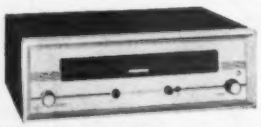

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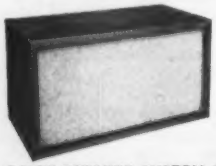

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Kit Division of *PRECISION Apparatus Company, Inc.*

Hi-Fi-Audio Product Review

TURNTABLE FOR STEREO

Channel Master Corporation of Ellenville, N. Y. has added a four-speed, stereophonic turntable to its line of audio components.

The Model No. 6652 is said to exceed NAB standards for wow, flutter, and

rumble. The unit has a heavy cast-aluminum turntable with rim-concentrated weight to provide smooth flywheel effect. The rotor of the specially designed 4-pole motor is electronically balanced and the motor is shielded to prevent hum and keep out dust.

A new suspension and mounting system permits the turntable to operate in complete electrical and mechanical silence. A built-in, illuminated strobe provides a continuous speed check. There is a vernier fine-speed control for making any corrections deemed necessary by the user.

The turntable handles 16⅔, 33⅓, 45, and 78 rpm discs. The idler is disengaged in the "off" position. A precision stylus gauge is included with the turntable at no extra cost.

"STROBOLAMP"

Switchcraft, Inc., 5555 N. Elston Ave., Chicago 30, Ill. has announced the availability of a new unit for checking the speed of a turntable or record player.

Known as the "Strobolamp," the unit involves placing the strobe disc on the record player turntable, setting the desired speed, and holding the lamp over the appropriate dots on the disc. When the speed is correct, the dots will appear to stand still.

The unit comes complete with a 6-foot cord. It will operate from any 117-volt a.c. source.

HI-FI DAMPING FELT

American Felt Company, 2 Glenville Road, Glenville, Conn. is now offering a special vibration damping material for sound system speaker enclosures and for isolating amplifier chassis, changers, and turntables from feedback.

The new product, SAE F13 audio felt, is ⅜" thick and is available to equipment manufacturers in bulk sheet or roll form. In one-square-yard pieces, the product is being made available to the retail trade as "Hi-Fi Felt" through *Continental Felt Co.*, 22 W. 15th St., New York, N. Y.

Besides providing 50% more effective damping throughout the frequency range from 50 to 15,000 cps, the felt has high resistance to vibration, is moth and flame resistant, and exhibits long life and freedom from matting and bottoming out.

A copy of the "Huff Report" on the audio properties of felt is available from the company at the above address.

"KNIGHT" STEREO TUNER

Allied Radio Corporation, 100 N. Western Ave., Chicago 80, Ill. has just released a new stereo FM-AM tuner as its "Knight" KN-135.

The new unit provides for reception of stereo FM-AM, FM only, and AM only. The tuner includes a rear-panel multiplex adapter jack, ready to accept a plug-in adapter for stereo FM multiplex broadcasts.

The FM and AM tuning controls are

completely separate with each control flywheel weighted. For direct stereo or mono tape recording, the tuner has two extra high-impedance outputs. FM sensitivity is 4 μv. for 20 db of quieting while AM sensitivity is 10 μv. for 20 db signal-to-noise ratio. FM response is 20-20,000 cps ±0.5 db. The tuner circuit uses 8 tubes plus a selenium rectifier.

The case is styled in a dark leathertone with a front panel in charcoal brown and gold. The unit measures 3⅜" x 11⅜" x 9".

CABLES FOR HI-FI

Belden Manufacturing Company, Chicago 80, Ill. has recently introduced two new cable items which have been specifically designed for the high-fidelity market.

A new, three-conductor, 32 AWG, shielded stereo phono pickup arm cable is the most recent addition to the firm's line which now provides a complete selection for 1-, 2-, 3-, and 4-conductor shielded and 2- and 4-conductor unshielded phono pickup arm applications.

The second item is the #8321 cellular-polyethylene-insulated hi-fi connecting cable for applications where a shielded, low-loss cable is indicated. A spiral-tinned-copper shield is provided for easier and neater connection. This new cable is being offered on 15, 25, 50, 100, and 500 foot spools.

"MATCHED TWIN" MIKES

Sonotone Corporation of Elmsford, N. Y. has recently introduced "Matched Twin" ceramic microphones for the live recording of stereo program material.

These CM-T10 sets are acoustically matched at the factory to a tolerance

of ±2 db. Jacked into any quality stereo recorder, the set feeds the tape a substantially flat 50-13,000 cps signal at an output level of −62 db.

Where greater sensitivity is required, the CM-T11 is recommended. Frequency response of this matched pair is 50-8000 cps ±2 db and sensitivity is 55 db below 1 volt per microbar.

The "heart" of these mikes is a rugged rubber-encased ceramic transducer which is said to be immune to extremes of both temperature and humidity. Controlled response is assured by an all-metal damping grid of new design. The one-piece, die-cast metal case is designed for easy hand use. For table use, chrome-finished table stands are available at additional cost.

ELECTROSTATIC SPEAKER SYSTEM

Monarch International, Inc., 7035 Laurel Canyon Blvd., North Hollywood, Calif. is marketing a new SP-100 speak-

er system which features four matched electrostatic elements and a special low-resonance, long-throw voice-coil speaker in a die-cast frame. This speaker features an unusual foam plastic suspended cone.

With outside dimensions of 18" x 22" x

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New 4-track stereo-record/stereo-playback tape recorder guild-crafted by Philips of the Netherlands

The exciting specifications on the new Norelco **CONTINENTAL '400'** *(EL3536/54) provide only an indication of what "the greatest Continental of them all" holds in store for the music lover, studio-recordist or high fidelity enthusiast who is seeking a professional quality stereo machine at a modest price.*

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the Commando is available in three models:

DELUXE Model "430"
A dual-impedance unit with A25 swivel adapter, on-off switch, cable connector
list price $38.50

LAVALIER Model "420"
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list price $30.00

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Manufacturers of world-famous Shure High-Fidelity Stereo Dynetic Phono Cartridges.

10", the SP-100 is finished in walnut and delivers a smooth response from 35 to 25,000 cps. The cabinet features a special, acoustically accurate, low-resonance duct system specifically designed for this speaker.

Additional details on the SP-100 will be supplied by the manufacturer on request.

PRE-ALIGNED TUNER KIT

PACO Electronics Company, Inc., 70-31 84th St., Glendale 27, New York is now offering the Model ST-45PA stereo FM-AM tuner kit which features separate pre-wired and pre-aligned AM and FM tuner circuits on two printed-circuit boards.

The only job required of the builder is to complete several minor wiring and assembly operations and the set is ready to operate. With the completely separate AM and FM circuitry, the new unit can receive simulcast stereo, FM separately, and AM separately. There is a multiplex socket provided on the chassis with space beside it for the future installation of a multiplex adapter.

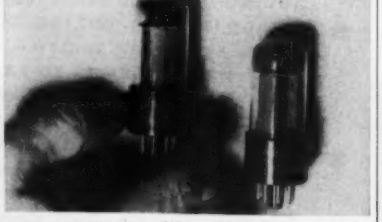
The tuner is housed in a gold and satin-black hooded case which has a two-lamp, edge-lighted dial. The satin gold panel is designed to blend in with either traditional or modern decor. Over-all dimensions are 15⅜" wide, 11¾" deep, and 5⅝" high.

The company will supply additional details and price on this new kit upon request.

HI-FI OUTPUT TUBES

The Electronic Tube Division, *Westinghouse Electric Corporation*, P.O. Box 284, Elmira, New York is now offering a new beam-power pentode which has been designed especially for use in audio amplifiers.

The new 7591 audio-frequency power output tubes are capable of high power and low distortion. In push-pull application, they will deliver up to 45 watts



power output with a total harmonic distortion not exceeding 1.5 per-cent. Operating conditions for this level of performance are: plate voltage, 450 volts; screen voltage, 400 volts; grid #1 voltage, −21 volts; maximum signal plate current, 72 ma. per tube; maximum signal screen current, 15 ma. per tube; and effective plate-to-plate load impedance, 6600 ohms.

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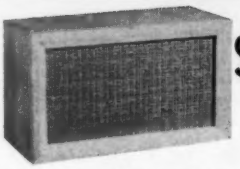

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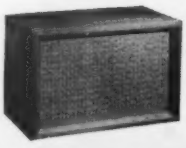
MODEL 6

Factory assembled, ready for finishing. Makes your 8" speaker sound like a million! Made of ½" hardwood ply, beautifully grained and smoothly sanded. 10" h. x 16" w. x 9" d. 9 lbs. Order two for matched stereo performance.

MODEL 1
4½ cubic feet of baffle space assures you crispest, cleanest bass response from any 12" speaker system. Full-grained white birch ply, with pre-attached bracing cleats for easy assembly. Kit includes everything you need for assembly. 29" h. x 20" w. x 12½" d. (5" legs). 25 lbs. $16.95



MODEL 2
Clear-grained on four sides for bookshelf or floor use. Acoustically accurate for 12" systems, with adapter board for 8" speakers. Sturdy, ¾" ply eliminates unwanted resonances, improves bass response. 14" h. x 21" w. x 11¾" d. 20 lbs.
In Birch, $14.50
In Walnut, $19.95

MODEL 13. Finishing kit; includes generous quantities of everything you need to do a professional, long-lasting finishing job, plus brush, sandpaper and easy-to-follow instructions. Specify: Mahogany, Walnut, Blonde, Oak, Fruitwood, Maple, Cherry, Ebony, Natural. **$3.88**

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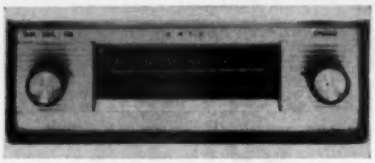
These new tubes use a T-9 glass bulb, an octal base, and are suitable for mounting in any position. Full details are available from the manufacturer on request.

FM TUNER FOR CARS

Eric Engineering Company, 1823 Colorado Ave., Santa Monica, California is in production on an FM tuner designed for automotive installation.

The tuner, Model FM 100, operates in any car with a 12-battery and through any regular car radio and speaker. An accessory 30" FM antenna



that bolts to the AM aerial is available, although the tuner may be operated with the AM antenna set at 30".

The compact 2⅞" x 8¼" x 7¾" unit features 1.5-μv. sensitivity for 20-db quieting, 20-20,000 cps frequency response, and low noise. Germanium diodes are used as discriminator and the circuit features a.f.c. with defeat.

The tuner can be attached under the dash in most cars by means of a metal bracket requiring only two screws. It is connected by two leads, one to the power supply and the other to the amplifier circuit of the car radio.

A data sheet giving full specifications on the Model FM 100 is available from the manufacturer.

DUAL-VOICE-COIL WOOFERS

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y. has recently introduced two new high-compliance, dual-voice-coil woofers which incorporate special 350-cycle crossover networks for the hi-fi enthusiast interested in building his own three-channel stereo speaker system.

Utilizing the principle that the stereo effect is largely determined by the frequencies above 350 cycles, these woofers feature two electrically separate voice coils on a single woofer chassis. When used in conjunction with two satellite speakers, low frequencies below 350 cps are blended through the single woofer cone, thus providing the desired stereo effect without resorting to complicated control filters or adapter networks.

The woofers are currently available in 8" and 12" models. Both employ 2" voice coils and feature 2-pound Alnico V magnets. The 8-inch version is SK-139 while the 12-inch model is SK-133. The 350-cps network is catalogued as KT-161 and is priced separately.

DUAL CONTROLS FOR STEREO

Audiotex Mfg. Co., 3225 Exposition Place, Los Angeles 18, Calif. is now offering two new dual control units for the remote control of the volume from stereo speakers.

Special impedance-matching "L" pad circuitry provides constant impedance.

With DYNAKIT you know you have the BEST!

The finest high fidelity you can buy at any price

DESIGNED FOR STEREO

PAS-2 $59.95

Stereo 70 $99.95

- New stereo control preamp with complete flexibility, fastest construction, and simplest operation
- All long life components. 1% parts used in critical circuits
- 2 pre-assembled heavy duty printed circuit boards make construction simple and bug-free
- Truly unmeasurable distortion—below 0.05%. Lowest possible noise
- Two outstanding 35 watt channels (160 watts peak) to power any speaker. Less than .5% distortion at rated power
- Unequalled transient response—excellent square wave performance
- Absolute stability with every loud-speaker without restriction of band-width
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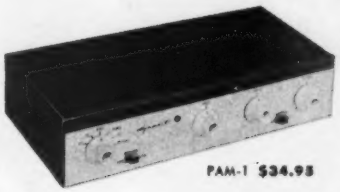

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- History-making "no-distortion" preamplifier which has never been equalled
- All feedback design and close tolerance parts result in lowest noise, lowest distortion and finest sound
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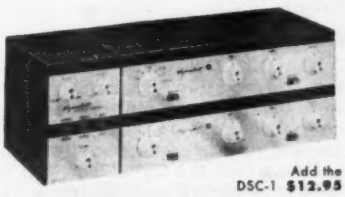

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- Unsurpassed flexibility
- Unitized panel or cabinet mount available as an accessory
- Just add a second mark III or Mark IV and you have the most recommended, most desired stereo amplifier ensemble
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"TOP RATED" again and again -and NOW AGAIN!

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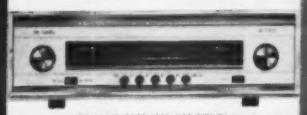

Model S-2200, FM-AM-MX Stereo tuner, Fair Trade Price—$179.50

AMERICAN AUDIO INSTITUTE

304 EAST 19th ST. PATERSON 4, N. J.

October 27, 1959

Sherwood Electronic Labs., Inc.
4300 North California Avenue
Chicago 18, Illinois

Gentlemen:

We find that the incorporation of a center-channel output and a damping factor selector in July, 1959, increases the Summary Rating of the Sherwood S-5000 to the highest of all 18 Stereo Amplifiers tested in the AAI Evaluation Test Reports.

Sincerely,

AMERICAN AUDIO INSTITUTE

Felix R Breny
Executive Director

The "Most honored of them all" S-5000 stereo amplifier-preamplifier is joined by the S-2200 stereo tuner. As with its "Top Rated" predecessors, the S-2200 features FM "Interchannel Hush" plus push button selector, internal plug-in adaptor for Stereo FM Multiplex, 2 "Acro-beam" tuning indicators, simulcast FM/AM stereo. All Sherwood tuners feature FM sensitivity below 0.95 microvolts and ⅓% distortion @ 100% FM. For further details write: Sherwood Electronic Laboratories, Inc., 4300 N. California Avenue, Chicago 18, Illinois.

For complete specifications write Dept. EW-5

The controls will turn the volume completely off in the "off" position and no extra "on-off" switch is required. Controls are rated at 10 watts continuous and 20 watts peak.

The new controls (Cat. No. 30-380 for

8 ohms and 30-382 for 16 ohms) are furnished in all-brass housings for surface mounting. Screw-type terminals eliminate soldering. The controls are said to be easy to install.

PROFESSIONAL RECORDER

Crown International of Elkhart, Indiana is now offering the new 714C, Stereo X professional tape recorder which records and plays 4-track stereo, plays 2-track stereo, and is capable of recording and playing monophonic tapes and program material.

Outstanding features of this new unit include three speeds, three motors, the ability to handle 10" reels, four microphone inputs, rack mounting, and automatic stop.

At 15 ips, the response is 50-28,000 cps ±2 db with flutter and wow .06% and a noise ratio of 57 db (measured by professional NAB standards). At 7.5 ips, response is from 40 to 17,000 cps ±2 db, flutter and wow is .09%, and signal-to-noise ratio is 54 db. At 3.75 ips, response is 30-9000 cps ±2 db, flutter and wow is .18% while the noise ratio is 51 db.

LOW-NOISE TUBE FOR AUDIO

The Tube Division of *Sylvania Electric Products Inc.*, Emporium, Pa. has introduced a nine-pin triode-pentode controlled for hum, noise, and microphonics and designed especially for hi-fi.

Designated the Type 7687, the new tube combines a coil heater, a rigid mount structure, and a cool-operating cathode to achieve minimum noise, hum, and microphonics. The new tube is designed primarily for compact high-fidelity systems in tone control amplifiers, phase-splitter, and high-gain voltage-amplifier circuits.

12-WATT AMPLIFIER

Model Engineering and Manufacturing, Inc. of Huntington, Ind. is currently marketing a new, moderate-power amplifier as its M-2.

Consisting of a chassis only, the unit measures 3½" high, 6¼" deep, and 12"

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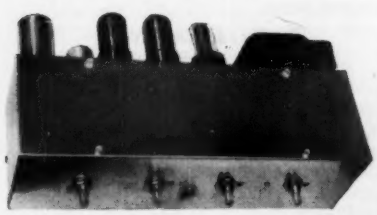
EW 560

long. It incorporates a loudness control as well as separate treble and bass controls, which provide 12-db attenuation at 5000 and 50 cps, respectively. The program selector control has positions for radio, TV, and three phono turnovers.

Outputs are at 8 and 4 ohms. Response



is from 20 to 30,000 cps. The unit can be used in pairs for stereo application or low-power mono installations.

The unit is available from the manufacturer at 55 Frederick St. in Huntington and additional details are available on request.

NEW FM TUNER

Sargent-Rayment Company, 4926 E. 12th St., Oakland 1, Calif. has recently introduced a new FM tuner, the Model SR-1020.

Using an advanced "tuning heart" design, the tuner utilizes a single diode and tube combination to perform the functions previously necessitating four separate tubes. As a result, fewer parts are required and heat radiation is greatly reduced, according to the company.

Complete operational flexibility is provided by enabling the listener to select "FM," "FM with AFC," or "FM Multiplex." Additional controls include a precision slide-rule dial, which is flywheel balanced, and an output level control.

The tuner is styled for compatibility with the company's other audio components. The metal cabinet is functionally designed to permit easy removal for custom installation. Literature is available on request. -30-

HAMFESTS SCHEDULED

THE Eleventh Annual Hamfest of the Hi-Plains Amateur Radio Club has been set for Sunday, May 15th, at Plains, Kansas.

Five states were represented at last year's get-together and the Club is hoping to better that record this year. A full program of ham activities has been planned. Contact Mrs. Eileen Goddard, KØTBU, club secretary, for additional details.

* * *

THE International Hamfest, an annual event for 26 years, has been scheduled for July 16 and 17 at Glacier Park, Apgar Campgrounds.

Since it is hoped that amateurs from all over the country will be able to attend, the group in charge of the event urges early reservations and advanced planning. Write or call George G. Nichols, W7IOJ, secretary-treasurer of the host group for programming and housing details. His home address is 1342 S. 6th West, Missoula, Mont. -30-

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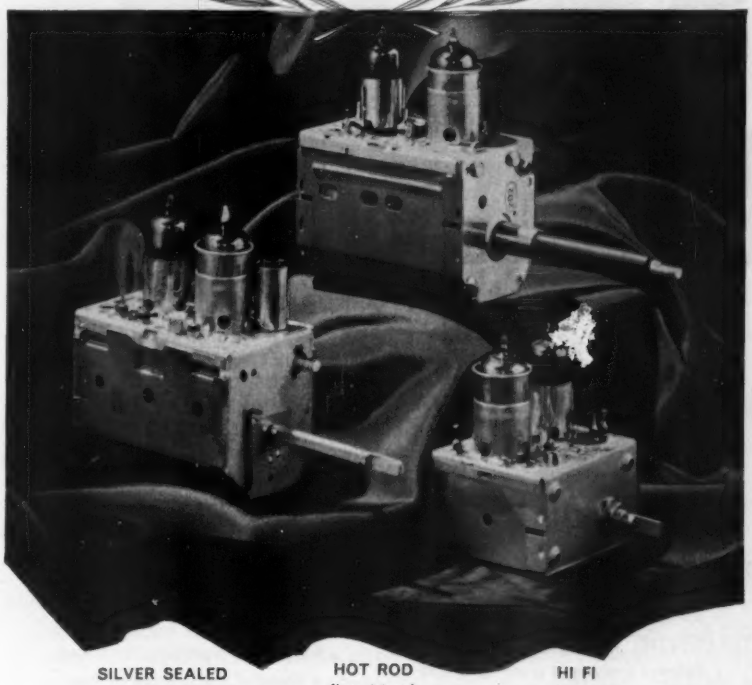

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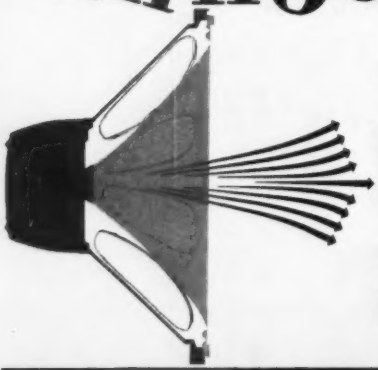

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The Capacitance Solver

(*Continued from page 66*)

connected in such a manner as to indicate the dip in grid current. The oscillator operates between 34 and 16.5 mc., which represents 0 and 50 $\mu\mu$f. respectively.

Circuit Details

One half of a 12AU7 (V_{1B}) is used as a half-wave rectifier. The output is filtered by R_8, C_6, and C_7. A combination isolation and filament transformer is used to eliminate any shock hazard. Capacitor C_5, across the "B+" supply output, provides an r.f. return for the oscillator circuit.

The other section of the 12AU7 (V_{1A}) is used as a hot-cathode oscillator. Variable capacitor C_2 is ganged to the calibration knob, while C_1 indicates the capacity. Coil L_1 is closely coupled to L_2 as shown in Fig. 1. The 24-inch length of 72-ohm twin-lead is connected to the terminals of L_1 and passes through a grommet on the front panel. Resistor R_1 lowers the "Q" of L_1 and prevents it from "pulling" the oscillator frequency.

The "eye" tube is used to measure the grid voltage. Resistor R_3 is connected directly to the grid (pin 7) of the oscillator. The lead to the "eye tube" grid is rather long and this resistor acts as an r.f. choke. An additional 1-megohm resistor (R_4) at the V_2 end of the wire completes the r.f. filtering. Resistor R_6 is the grid load and forms a voltage divider in conjunction with R_3 and R_4. Plate voltage for the "eye" is supplied through R_7.

Construction

The unit is self-contained in a 4" x 5" x 7" chassis box. The majority of components are mounted on a "U" shaped bracket, secured to the front panel. The sockets for V_1 and V_2 and transformer T_1 are located on this bracket. The filter capacitors, switch S_1, and a three-lug tie-point are mounted on the left side of this bracket (when viewed from the rear, Fig. 3). The components associated with V_{1A} will be found on the right side of the bracket (Fig. 4). Variable capacitor C_1 is mounted directly on the front panel.

The circuit is not particularly critical and all but the oscillator components can be moved around to suit your particular chassis box. The constructor should follow the coil details and oscillator layout closely however. The usual practice of keeping the oscillator circuit leads as short as possible should be observed.

Calibration

When the unit is completed, check the wiring and "B+" resistance, then apply power. There should be about 130 volts d.c. at pin 4 of V_2 when the tubes reach operating temperature. The eye tube should light up green and an almost complete closing of the eye

indicates that the oscillator circuit is working properly.

Stretch the twin-lead out, set the calibrated dial to "0" $\mu\mu$f. (minimum capacitance), and adjust the calibration capacitor to make the eye open. This should occur near half capacitance. If it occurs near maximum capacitance, squeeze the turns of L_2 or spread the turns of L_1. Conversely, if the eye opening occurs near minimum capacitance, spread coil L_2 or compress the turns of L_1. As soon as you get the eye to open with C_1 at zero and C_2 at about half capacitance, the dial can be calibrated using known values of capacitance.

Additional Notes

You will notice that the parts list specifies that three plates be removed from variable capacitor C_1. This is necessary to make 50 $\mu\mu$f. come out at full scale on the dial. If the plates are left in you will be able to read values up to about 75 $\mu\mu$f., but the smaller values, at the bottom of the scale, will be compressed. By the same token, you can spread out 0-10 $\mu\mu$f. over the whole dial (if you like) by removing additional plates from C_1.

The photographs accompanying this article are of the original version, built from available junk-box parts, rather than of the universal version shown in the schematic. Accordingly, there are some differences to take into account. For example, the item marked "see text" in Fig. 3 is a surplus oil-filled capacitor used as the filament-dropping reactance in the original version which lacked an isolation transformer. In the present version, transformer T_1 is mounted in the place occupied by the capacitor. Also, the 8-pin socket shown in Fig. 3 for V_2 accommodated a surplus eye tube in the original. This is simply replaced by a 6-pin socket for the widely available 6E5.

This instrument has a wide variety of applications. For example, it can be used to measure stray tube and actual capacitance in r.f. and video circuits; to determine the necessary inductance for resonance or for other purposes. It can also be used to measure the extent of capacitor drift to determine the value of compensating capacitors to be added. —30—

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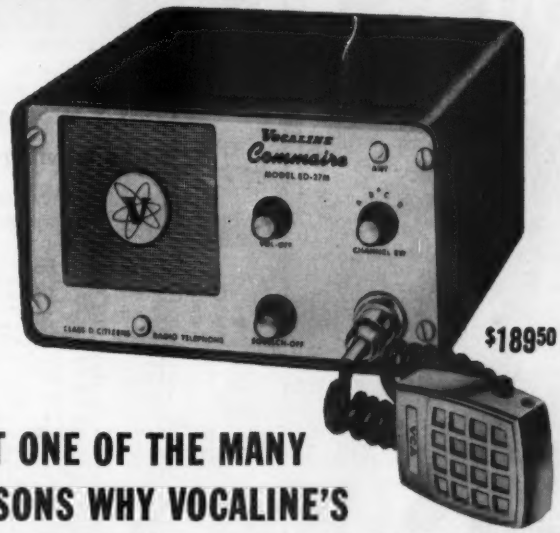

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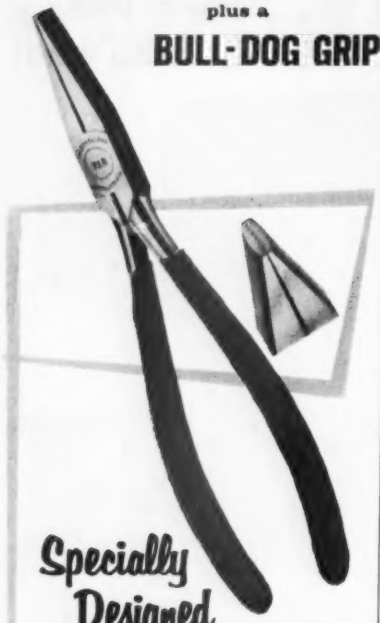

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New Tube Tester Data

Owners of Seco tube checkers: Keep up-to-date with this listing of the most recent tube types.

SECO MODEL 107

P.S.	DMC Load	Type	Fil. V	F,Fj	Q	Load	Spec
		2ER5	2	3.4	2	75	
		2ER5	2	3.4	6	100	
		2ES5	2	3.4	2	75	
		2ES5	2	3.4	6	100	
7E	20	2EV5	2	3.4	1	70	
7E	20	2FV6	2	3.4	1	40	
		2J2	2	146.258	TC	100	D
7E	20	3EV5	3	3.4	1	70	
9B	2X30	5EU8	5	4.5	2	55	
		5EU8	5	4.5	9	30	A
9I	2X28	5FV8	5	4.5	1	30	
		5FV8	5	4.5	9	60	A
9B	2X30	5GH8	5	4.5	2	55	
		5GH8	5	4.5	9	30	A
		6DZ7	6	2.7	1	85	
		6DZ7	6	2.7	5	85	
		6DZ8	6	4.5	1	50	
		6DZ8	6	4.5	3	15	
8G	10	6EA7	6	7.8	1	25	A
	80	6EA7	6	7.8	4	100	
		6ER5	6	3.4	2	75	
		6ER5	6	3.4	6	100	
		6ES5	6	3.4	2	75	
		6ES5	6	3.4	6	100	
7E	20	6ES6	6	3.4	1	45	
6E	20	6ET6	6	3.4	1	45	
9B	2X30	6EU8	6	4.5	2	55	
		6EU8	6	4.5	9	30	A
7E	20	6EV5	6	3.4	1	70	
		6EX6	6	2.7	5	15	
8D	10	6EY6	6	2.7	5	15	
		6EZ8	6	4.5	2	50	B
		6EZ8	6	4.5	7	85	B
		6EZ8	6	4.5	9	85	A
		Third Section will open Eye					
		6FH8	6	4.5	2	30	
		6FH8	6	4.5	6	30	
		6FM8	6	4.5	8	80	
		6FM8	6	4.5	2	80	
		6FM8	6	4.5	6	80	
9I	2X28	6FV8	6	4.5	1	30	
		6FV8	6	4.5	9	60	A
9D	2/25	6FW8	6	4.5	2	25	
		6FW8	6	4.5	7	25	
		6FY8	6	4.5	1	60	
		6FY8	6	4.5	3	20	
9B	2X30	6GH8	6	4.5	2	55	
		6GH8	6	4.5	9	30	A
9D	2X25	7DJ8	7	4.5	2	40	
		7DJ8	7	4.5	7	40	
		9DZ8	9	4.5	1	50	
		9DZ8	9	4.5	3	15	
		9EJ5	9	4.5	2	20	
		10DR7	9	4.5	23	40	A
		10DR7	9	4.5	7	40	
8G	20	10EG7	9	7.8	1	30	
	30	10EG7	9	7.8	4	60	

P.S.	DMC Load	Type	Fil. V	F,Fj	Q	Load	Spec
		12AS5	12	3.4	25	20	
7E	30	12BZ6	12	3.4	1	40	
9D	2X25	12DM7	12	4.5	2	60	
		12DM7	12	4.5	7	60	
		12DZ8	12	4.5	1	50	
		12DZ8	12	4.5	3	15	
		12FQ8	12	4.5	2	50	A
		12FQ8	12	4.5	7	50	A
		12FR8	12	4.5	1	100	
		12FR8	12	4.5	3	100	
		12FR8	12	4.5	8	100	
		12FX8	12	4.5	2	100	
		12FX8	12	4.5	6	100	
		12FY8	12	4.5	1	60	
		12FY8	12	4.5	3	20	
		18DZ8	19	4.5	1	50	
		18DZ8	19	4.5	3	15	
7E	25	18FW6	19	3.4	1	50	
7E	100	18FX6	19	3.4	1	75	
7E	65	18FY6	19	3.4	1	100	
		18FY6	19	3.4	1	100	
		18FY6	19	3.4	5	100	40%
		18FY6	19	3.4	6	100	40%
7E	30	18GD6	19	3.4	1	50	
7D	65	18GE6	19	3.4	1	100	
		18GS6	19	3.4	5	100	40%
		18GE6	19	3.4	6	100	40%
9I	25	19CL8	19	4.5	1	40	
	30	19CL8	19	4.5	9	40	A
9B	30	19EA8	19	4.5	2	50	
	25	19EA8	19	4.5	9	30	A
		21EX6	19	2.7	5	15	
		25FY8	25	4.5	1	60	
		25FY8	25	4.5	3	20	
		32ET5	35	3.4	25	20	
		35DZ8	35	4.5	1	50	
		35DZ8	35	4.5	3	15	
		36AM3	35	3.4	5	10	
		50FY8	50	4.5	1	60	
		50FY8	50	4.5	3	20	
		7079	6	3.6	2	85	
		7079	6	3.6	7	85	
		7083	6	3.4	7	70	
7A	2X30	7244	6	3.4	5	85	
		7244	6	3.4	6	85	
7G	25	7245	6	3.4	156	45	
9D	2X100	7247	12	4.5	2	80	
		7247	12	4.5	7	80	
		7355	6	2.7	6	10	
8D	10	7408	6	2.7	5	10	
7E	20	7543	6	3.4	1	40	

The data listed here may be ordered from Seco Electronic Mfg. Co., 5015 Penn Ave., S., Minneapolis, Minn. in such a form that it can be included in the Model 107 flip-chart kit. This addition, available at $2.00, is Seco Part No. FC 3-260.

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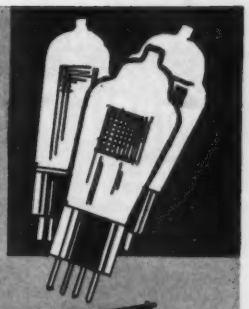

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OZ4	3BC5	6AB4	6BA6	6CL6	6S8GT	7B5	12AT7	12SJ7	38
1A7GT	3BN6	6AC7	6BC5	6CM6	6SA7	7B6	12AU6	12SK7	39/44
1B3GT	3BZ6	6AF4	6BC8	6CM7	6SD7GT	7B7	12AU7	12SN7GT	41
1C6	3CB6	6AG5	6BD6	6CN7	6SF5	7B8	12AV6	12SQ7	42
1C7	3Q4	6AH4GT	6BE6	6CQ8	6SF7	7C4	12AV7	12V6GT	43
1F4	3S4	6AH6	6BF5	6CR6	6SG7	7C5	12AX4GT	12W6GT	45
1F5	3V4	6AK5	6BG6G	6CS6	6SH7	7C6	12AX7	12X4	50A5
1G4	4BQ7A	6AL5	6BH6	6CU5	6SJ7	7C7	12AZ7	14A7/12B7	50B5
1H5GT	4BS8	6AM8	6BJ6	6CU6	6SK7	7E5	12B4	14B6	50C5
1L4	4BZ7	6AN8	6BK5	6D6	6SL7	7E6	12BA6	14Q7	50L6
1L6	4CB6	6AQ5	6BK7	6DE6	6SQ7	7E7	12BA7	19	56
1N5GT	5AM8	6AQ6	6BL7GT	6DG6GT	6SR7	7F7	12BD6	19AU4GT	57
1R5	5AN8	6AQ7	6BN6	6DQ6	6T4	7F8	12BE6	19BG6G	58
1S5	5AT8	6AR5	6BQ6GT	6F5	6U8	7G7	12BF6	19J6	71A
1T4	5AV8	6AS5	6BQ7	6F6	6V6GT	7H7	12BH7	19T8	75
1U4	5AZ4	6AT6	6BR8	6H6	6W6GT	7N7	12BQ6	24A	76
1U5	5BR8	6AU4GT	6BS8	6J4	6X4	7Q7	12BR7	25Z6GT	77
1V2	5J6	6AU5GT	6BY5G	6J5	6X5GT	7S7	12BY7	26	78
1X2	5R4	6AU6	6BZ6	6J6	6X8	7X6	12CA5	27	80
2AF4	5U4	6AU8	6BZ7	6J7	6Y6G	7X7	12CN5	35	84/6Z4
2BN4	5U8	6AV5GT	6C4	6K6GT	7A4/XXL	7Y4	12D4	35A5	117Z3
2CY5	5V4G	6AV6	6CB6	6K7	7A5	7Z4	12F5	35B5	
3A4	5V6GT	6AW8	6CD6G	6N7	7A6	12A8	12K7	35C5	
3A5	5X8	6AX4GT	6CF6	6Q7	7A7	12AB5	12L6	35W4	
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Neon-Lamp Oscillators

(*Continued from page 59*)

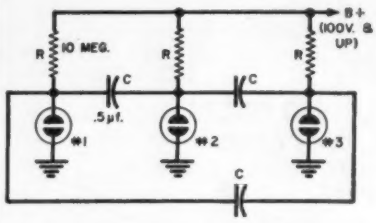


Fig. 3. Extension of sequence flasher.

shown in Fig. 8. Lamps #3 and #4 will oscillate at a frequency which is an integral multiple of the lamp #1 lamp #2 switching frequency. Using the circuit constants indicated, lamp #3 lamp #4 switching frequency was five times that of lamps #1 and #2.

These glow-lamp circuits are intended merely as guides to many interesting multi-lamp oscillator applications. The circuits shown are by no means all possible configurations. An evening spent with a breadboard, a power supply, and the usual assortment of junk-box parts should stimulate the development of many new and interesting applications. —30—

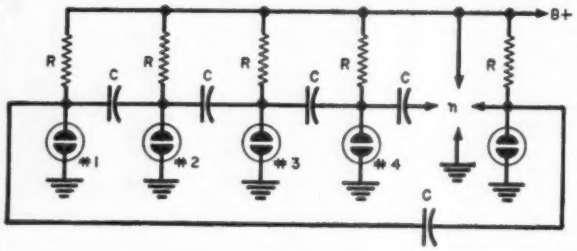


Fig. 4. Oscillators of this type have non-critical timing. Any number of basic stages may be added if it is desired to do so.

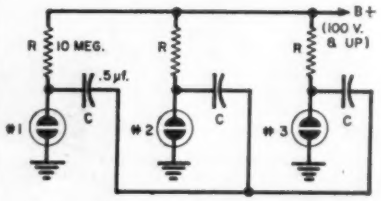


Fig. 5. Variation of the 3-lamp circuit.

A variation of the three-lamp circuit is shown in Fig. 5. This flasher also follows a regular sequence with each lamp on for one-third of the total time.

When more than three lamp *modules* are connected (as in Fig. 4). the lamps will normally establish an odd pattern. Instead of the expected 1,2,3,4,.....*n* repetition, patterns such as 1,3,*n*,4,2, ...or *n*,2,3,1,4,.....would be typical cases. Each lamp will be lit for 1/*n*th the total time. Oscillators of this type might be useful in non-critical timing applications and as eye-catchers in advertising displays. Circuits using up to five lamps have been tested and found to establish stable patterns.

An interesting two-lamp circuit is shown in Fig. 6. Using circuit constants as indicated, the resulting sequence is 1,1, (1 & 2), 1,1, (1 & 2)...., etc. By shunting a high resistance (approximately 10 megohms) across C_1, a sequence such as the following may be obtained: 1,1,1,1, (1 & 2), 1,1,1,1, (1 & 2)...., etc.

A variation of the two-lamp oscillator (Fig. 7) will establish the sequence 1,2,2,1,2,2,.....with the circuit constants shown.

Additional capacitance connected in almost any fashion in the multi-lamp oscillator of Fig. 4 will result in many interesting sequence patterns.

A twin multivibrator operating at two integrally related frequencies is

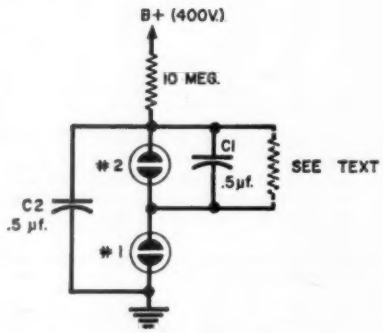


Fig. 6. Circuit diagram showing interesting two-lamp arrangement discussed.

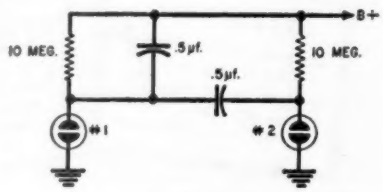
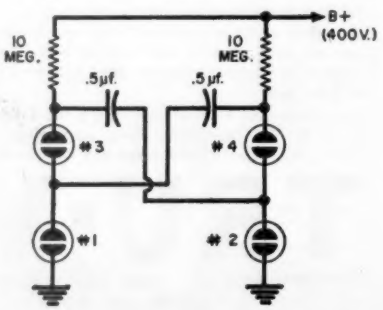


Fig. 7. Variation of two-lamp circuit.

Fig. 8. A twin-multivibrator circuit.



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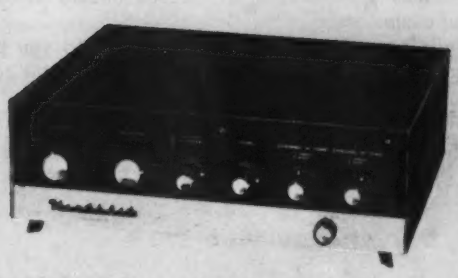

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XR-2P (high-impact plastic) 6 lbs.

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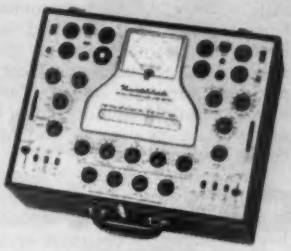

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Sound on Tape

By BERT WHYTE

THE tape picture this month is brightly optimistic. It would seem that the recent reports concerning new developments in tape cartridges were premature and that the emergence of the ⅛th inch tape, or variations thereof, appears slated for the indefinite future.

Thus we have entered a period of relative stability . . . the 4-channel tape is finally gaining momentum and, from reports from the field, is rapidly becoming the medium of choice for stereo tape enthusiasts. Most dealers are very sure that the Fall will bring a most significant increase in both the sale of 4-channel tapes and tape units to play same.

The skepticism of die-hard, two-channel advocates is dwindling as 4-channel duplication procedures have been brought to optimum quality and the current crop of 4-channel tapes reflects this improvement. Given a two- and a four-channel tape of the same material, both duplicated with the same care and precision and both played on top-notch equipment, there is little to choose between them as far as quality is concerned. Even though I still detect somewhat higher output and a slightly better signal-to-noise ratio in the two-channel type, the difference is much less marked than was the case with earlier 4-channel material and, with certain tapes, appears to be a factor that can be dismissed altogether.

As noted previously, another factor in strengthening the tape market is the entrance of more companies into the field of recorded tape. American *Decca* joined the ranks and of course the big news was the entry of *London Records*. With their formidable catalogue of symphonic and operatic material, this pushed 4-channel tape right into the foreground.

The *Ampex*-sponsored *United Stereo Tapes* is doing a good job of making tape readily available again but here I would like to sound one short, sour note . . . with *Westminster* temporarily out of the picture, the classical tapes issued by *UST* are drawn mostly from *Mercury, Everest,* and now *London* and from a few of the smaller companies.

All of these companies have far more classical tapes than the *UST* catalogue lists and increases in this list appear agonizingly slow. My one disappointment with the first *London* release is that I feel the classical side could have been much more representative.

Well, I guess we shouldn't look gift horses in the mouth, but I still feel that even though four-channel tape has been brought down to an average $7.95, this still represents a sizable piece of change and most of the folks I have talked to want to invest that kind of money in the permanent worth of classical material rather than in the transistory values of pop material. I don't say that pop tape doesn't sell . . . it probably outdoes classical . . . but if more classical tapes are issued, it will mean just that many more sales and an even more stable and stronger market.

I only managed to snaffle one of the new *London* tapes, but I am assured more will arrive in time for next month. That's for me!

MENDELSSOHN
SYMPHONY #4 ("Italian")
SCHUBERT
SYMPHONY #5
Israel Philharmonic Orchestra conducted by George Solti. London Stereotape, 4-channel, LCL80009. Price $7.95.

It is quite a pleasure to be reviewing a *London* stereo tape. Way back during the height of the tape boom, I often lamented the fact that the great *London* catalogue was one of the few not represented on stereo tape. I have learned through experience not to judge the quality of a company's tapes by the first output, as invariably there are "teething" troubles that must be resolved. In this instance, we have a tape that must be judged very good but not up to the standards of which we know *London* is capable.

The seat of the problem here appears to be that the original *London* masters are recorded according to the British CCIR equalization standard, which differs from our own. According to reports, matching these tapes to our equalization was not the easy task it might appear. Probably tapes subsequent to this will be improved, but the direct result here is that the string tone, especially in the first violins is on the thin side and hasn't the brilliance usually associated with *London* sound.

It would also seem that the bass response, always a notable *London* feature, is somewhat subdued. But for all this, this is still quite a listenable tape. Balance between the various choirs is particularly good and there is excellent definition. *London* appears to use a modified version of the European-favored "M/S" stereo technique, with the result that we have a good "middle" although not as prominent as in the

straight M/S recordings of other companies . . . and directionality is better than the M/S but still somewhat more subtle than that which prevails with American stereo.

The over-all impression is one of unforced naturalism, with the fine definition aided by careful attention to hall reverb with a view towards good depth perception. Dynamic range and frequency response was good but not sensational, probably more from the point of the type of music rather than technical shortcomings. Signal-to-noise ratio was quite good, while at a good room-filling level the hiss was below the point of obtrusiveness.

The performances by Solti are quite good, his "Italian," not quite possessing the fire and excitement of several other readings. The Schubert is a lovely work that deserves more frequent hearing and in this Solti is wholly commendable.

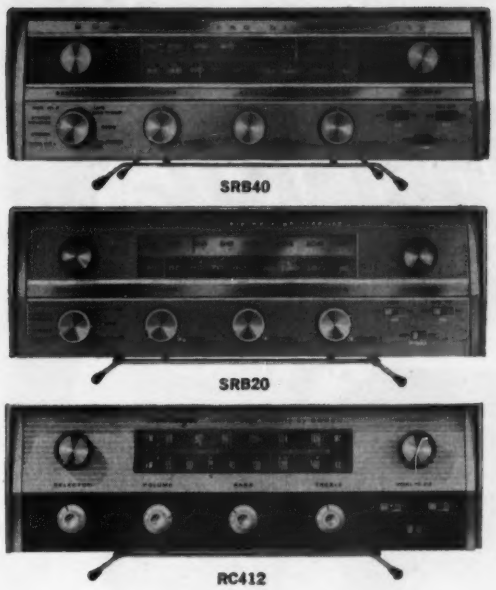
HIGH SPIRITS
Demonstration tape. Audiotape 2-channel Stereo. Price, see text.

This is presumably intended to show how good music can sound when stereophonically recorded on *Audiotape*. Well I have no quarrel with my friends at *Audiotape* . . . I've used their fine product for years and have always been satisfied. But I'm afraid I must take issue with this tape as an example of high quality recording. The best I can say is that it is "pretty good." Some selections fare better than others, but none, in my estimation, reach the overall level of quality of the outstanding commercial tapes. Now string tone is pretty clean here, as is woodwind, but the brass is coarse and low percussion has an abominable muddy resonance.

The tympani in the Beethoven and Tchaikovsky pieces are the worst offenders. It is not so much a matter of clean recording as it is a matter of mike placement in a hall that appears to have an excessive low frequency resonance. Stereo effects were rather more deliberate which is understandable and forgivable under the circumstances and the tape did exhibit an exceptionally low level of tape hiss.

The less said about the performances the better . . . the "Carmen" excerpt is acceptable, the rest are pretty sad and some of the playing is very questionable. Among the selections on the tape are some Strauss Waltzes and excerpts from Beethoven's "First Symphony," Tchaikovsky's "Capriccio Italien," Bizet's "Carmen," and Berlioz' "Rakoczy March."

Audiotape's objective, of course, is to sell raw tape, and the availability of a recorded tape "High Spirits" is sort of a bonus for those interested. If you buy two reels of *Audiotape*, one recorded ("High Spirits") and the other raw (a 7-inch reel, 1200 feet on 1½-mil plastic base), you simply pay for two raw tapes plus an extra dollar. I assure you this is worth the money. You have a choice since "High Spirits" is available as a half-hour of dual-track stereo, an hour of 4-track stereo, or an hour of dual-track monophonic sound. –30–



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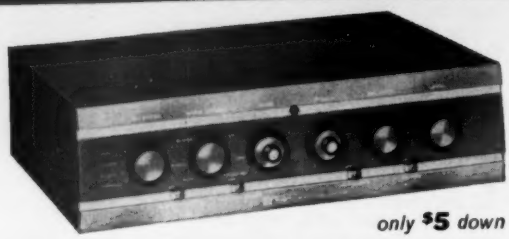

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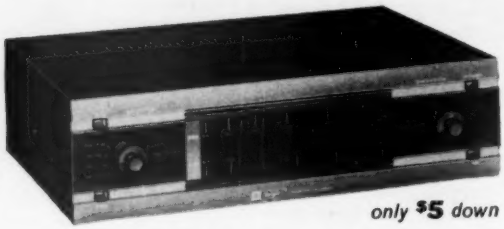

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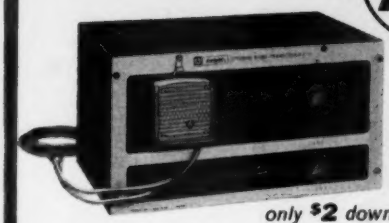

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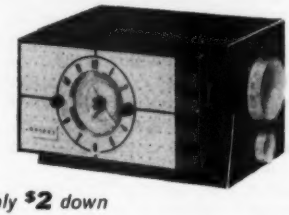

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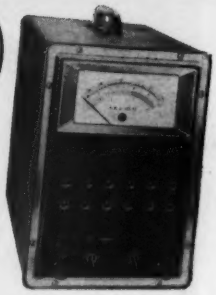

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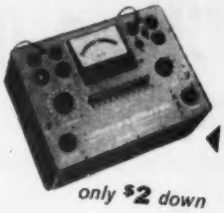

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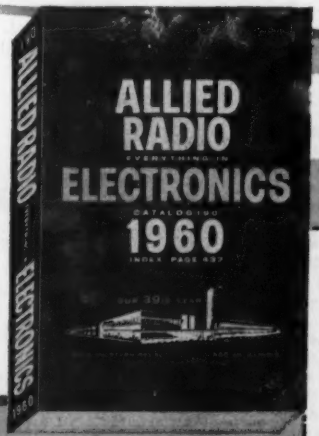

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Walter Ermer, Sr., W8AEU, wins Edison Award for his 300-man voluntary amateur radio emergency corps.

THE recipient of the 1959 Edison Radio Amateur Award is Walter Ermer, Sr., W8AEU, in recognition of his outstanding organizational and administrative ability in providing Cleveland, Ohio with a 300-man voluntary amateur radio emergency corps.

During 1959, this corps handled vital mobile radio communications on 23 occasions, including storm and tornado warning emergencies, floods, and recovery of lost persons. Communications for many fund drives and sporting events, including traffic, crowd, and race control at sports-car races, were also furnished by this group.

The corps has 304 licensed radio amateur operators, 197 radio-equipped automobiles, 77 "walkie-talkies," and 26 emergency power generators.

The success of this emergency communications corps is directly attributed to Mr. Ermer's organizational ability and leadership.

The Edison Radio Amateur Award was established in 1952 by the *General Electric Co.* to recognize the many outstanding public services rendered by radio amateurs.

The Award is presented annually to a licensed radio amateur who, while pursuing his hobby, has performed a meritorious service in behalf of an individual, group, or the general public. The recipient is selected by a panel of judges from among candidates nominated by persons familiar with the service rendered.

The judges who selected this year's award winner were: Commissioner Rosel Hyde of the FCC; Robert Edson, of the American National Red Cross; and E. C. Handy, vice-president of ARRL.

The award winner receives a special trophy and a check for $500 at a ceremony held annually in the nation's capital, and attended by prominent military and civilian communications and electronics industry figures. —30—

Sixteen families were rescued by boat during Cuyahoga River flood near this spot in Jan., 1959, by Ted Posey (right), K8KKO, one of Cleveland's 300-man amateur radio emergency corps directed by Walter Ermer (pointing). Reminiscing here with the radiomen are two boys, Robert and Gregory Tediardi, who were among those rescued then.

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• CITIZENS RADIO FOR SERVICE TECHNICIANS

As Citizens Band Radio expands in private and business usage, so does a tremendous opportunity for local servicing. Many Citizens Band Owners are not qualified to do the required repair and maintenance work and manufacturers have made no move to step into the breach. It's a new and challenging field for the local serviceman! This feature is a basic analysis of Citizens Band Circuits that every service technician can use.

• MEASURING TAPE SPEED

Tape speed accuracy is a must for true hi-fi reproduction, and June ELECTRONICS WORLD brings you an authoritative discussion of commercial strobe-disc devices currently available for checking speed. Complete with illustrations.

• DEPTH FINDERS

Sonar systems are indispensable to the small boatman for locating fish, shoals, sand-bars, and reefs. Here's a complete rundown on depth finders: what's available...how they work...maintenance and service tips...and some exciting new innovations.

• RADAR SPEED METERS & TRAFFIC CONTROL

The story behind the speed traps and radar speedmeters that have become vital to traffic safety on the nation's highways. Features a complete rundown on how these devices work, what they are capable of doing (and not doing)—supplemented with important diagrams and illustrations.

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By
BERT WHYTE

CERTIFIED RECORD REVUE

BY NOW many of you will have seen the ads from one of the leading makers of packaged units in which the claim is made that their consoles have "three-channel stereo." I have railed against this before and other critics have also lambasted it. It is, of course, not true three-channel stereo by any stretch of the imagination—but merely a variation on the "derived-third-channel-from-two" theme.

This company has both a name and money for advertising and a neat sales pitch which, in demonstrating the unit, really convinces the tyro that this is the cat's whiskers. We'll concede the point that, properly set up in the right acoustical climate, a derived third-channel can sound pretty good. Undeterred by complaints, this firm has kept on with this pitch and has enjoyed considerable sales success.

So, now guess what is happening? You hit it on the head . . . the copycats are loose and next Fall we will be inundated with such items as "trio-o-rama," "tri-sonic," etc., etc. One can only shudder at the crimes which will probably be committed in the name of three-channel stereo.

My question is, what ever will the Madison Avenue mahouts call real honest-to-gosh three-channel stereo when it ultimately makes its appearance? The sorry part of this whole thing is that many people are being sold a bill of goods and when the real thing *does* come along, there is going to be a real confusin' mess, which can only hurt both camps.

Funny part of this whole thing is that the cynic who shrugs his shoulders and says, "so what . . . real three-channel stereo is strictly wild blue yonder"—doesn't realize that the existence of these so-called three-channel machines and the constant advertising is bound to advance the day when the McCoy will actually appear.

Some of these "derived type" stereo units actually have three speakers and three amplifiers and some bright and enterprising lad is going to figure that with a little modification and the availability of true three-channel recordings, he can make honest stereo out of these units which now bear false labels. It will be interesting to note just how long it will take before this idea bears fruit!

MENDELSSOHN
VIOLIN CONCERTO IN E MINOR
LALO
SYMPHONIE ESPAGNOLE
Mischa Elman, violinist with Vienna State Opera Orchestra conducted by Vladimir Golschmann. Vanguard Stereo VSR2047. Price $5.95.

I was not too happy with Elman's debut on *Vanguard* with the Khachaturian concerto and so it is a pleasure to have him on this record in material more to his style and talents. His Mendelssohn is a lovely, lyrical thing, smooth of contour, where years of countless performances have made this a polished gem. His tone shines through here as it did not in the Khachaturian, and although entering his 50th year on the concert stage, he has not lost any technical facility.

His Lalo reading is somewhat subdued and does not have the solidity and intensity of the recent Ricci version, but some may prefer this smoother and more sophisticated approach.

The sound throughout is excellent, with Elman's violin staying put just left of center. Directionality was good, and the balance between the violin and orchestra fairly neutral. The reverb was nicely handled here and lends considerable depth to the sound. For Elman enthusiasts, this is the best he has ever been recorded.

BEETHOVEN
PIANO CONCERTO #3
Wilhelm Backhaus, pianist with Vienna Philharmonic Orchestra conducted by Hans Schmidt-Isserstedt. London Stereo CS6094. Price $5.98.

This is Beethoven in the grand tradition and few pianists today can realize this concerto as effectively as Backhaus. Some may consider him a little too pedantic, but none can dispute the authority of his reading, nor quibble with his richly sonorous tone, his expressive phrasing, and his marvelous control of dynamics and tensions. Schmidt-Isserstedt affords a sympathetic accompaniment and the engineers have treated piano and orchestra most kindly. Both are miked medium-close with an approximately neutral balance. Piano transients are very clean as is the orchestra in general. Good stereo directivity, but piano stays in its appointed place in the ghosted middle. Outstanding here is the superb sense of depth afforded by the unique acoustics. As it stands now, this is the preferred stereo recording of this work.

SIBELIUS
SYMPHONY #2
Detroit Symphony Orchestra conducted by Paul Paray. Mercury Stereo SR90204. Price $5.98.

What's this? Frenchman Paul Paray with Sibelius? Well, why not? After all it is a romantic symphony and Paray can play the romantics as well as anyone. This is not what you would call a definitive version and Paray's notion of dynamics and phrasing are not in the classic tradition of this work, but no one can deny that he makes of this an exciting experience.

The orchestra responds to his urgings magnificently and the playing of the first strings is especially praiseworthy. The sound is hugely proportioned and is an eloquent tes-

timony to what good stereo should be like. Except for a slight bass heaviness (probably due to the Ford Auditorium) it is otherwise thrilling and certainly qualifies this as the best sounding stereo record of this work.

BRAHMS
SYMPHONY #4
Columbia Symphony Orchestra conducted by Bruno Walter. Columbia Mono ML5439. Price $4.98.

Bruno Walter's Brahms "4th" is uniquely his own . . . no one else quite matches the romanticism with which he imbues the work. It is unabashedly a Viennese performance, redolent of gemutlichkeit. His tempi are leisurely and he develops no tensions as do so many of his peers. It is by no means "pure" Brahms, but will be the choice of many who are not concerned whether he dots every "i" and crosses every "t." Those who like their Brahms more robust will have to seek other recordings.

Soundwise this is generally good, except for some bass heaviness and a tendency towards lack of definition in the *tuttis*.

HANDEL
THE WATER MUSIC
Vienna State Opera Orchestra conducted by Felix Prohaska.

THE ROYAL FIREWORKS MUSIC
Vienna State Opera Orchestra conducted by Edmond Appia. Vanguard Stereo SRV115SD. Special demo price $2.98.

Here is a really good buy in a stereo record. Take the sprightely "Water Music" of Handel and his equally imposing "Royal Fireworks Music," give them both good intuitive performances and finally wrap them in superb stereo sound. Result? Happy listening. The sound throughout is very clean, well balanced, with fine directivity and depth and good ghost fill. As a final fillip, put the record on special sale at $2.98. You can't lose on this one!

MOZART
SYMPHONY #32
SYMPHONY #38
London Symphony Orchestra conducted by Peter Maag. London Stereo CS6107. Price $5.98.

Young Maag is getting quite a reputation as a Mozart specialist and this latest effort would seem to bear this out. The 38th ("The Prague") is the better known of the two and it receives a performance, which in all aspects seem remarkably acceptable. His tempi are impeccable, his phrasing and dynamics very expressive, and he exhibits no mannerisms to annoy one. In fact, his performance sounds for all the world like a slightly speeded up Sir Thomas Beecham.

The stereo is very good, recorded somewhat closer up than is usual with *London*. Directional effects are more noticeable than usual, but a good depth perspective helps a great deal. The sound also seemed brighter and at a higher volume level than has been the custom with recent *London* recordings. The Symphony Number 32 is an ingratiating little work, originally intended to be an Overture, and here, too, Maag shows his mettle, with a fine performance.

HANDEL
TWELVE ORGAN CONCERTOS
Karl Richter, organist, conducting the Chamber Orchestra. London Stereo CSA2302. Price $17.85. Three discs.

This is a wonderful set and is highly recommended to lovers of baroque organ music. Richter is an authoritarian and plays with great conviction and conducts at the same time. These were recorded on the organ of St. Marks in Munich and the resulting sound

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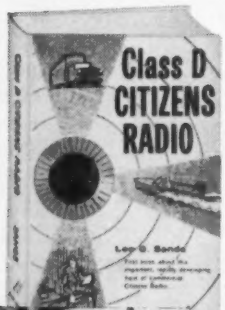

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is quite fascinating. The Chamber orchestra is seated and miked much closer than the organ so that one hears the organ just a little diffusely in a rather long reverb period and then hears the orchestra with much more detail and intimacy even though the reverb remains the same. It is an eerie effect but works out very well for these pieces.

There isn't too much stereo effect here in terms of direction, but the stereo is of great value in coping with the long reverb and in heightening the illusion of depth and reality. The music is among Handel's best, and while I don't think anyone could digest all twelve at one listening, be sure to hear them all, for each is a gem unto itself.

BACH

PRELUDE AND FUGUE IN D MAJOR, A MINOR, E MINOR

Marcel Dupré, organist. Mercury Stereo SR90227. Price $5.98.

These Bach "Preludes and Fugues" were recorded in Saint-Sulpice, where the great organist Marcel Dupré has played for so many years. The organ itself is considered the largest instrument in continental Europe. The recording problems encountered here were indeed formidable and it is a credit to *Mercury's* engineers that they succeeded as well as they did.

They had to contend with the excessively long reverb of the church and the ideal, of course, was to try and maintain detail and "presence" in the sound and yet not lose the characteristic flavor of the reverb, nor get so much reverb that everything else is swamped. They have done well, as most of the higher stops are clear and articulate, but the bass stops, the big pedals, are less discrete and are at times on the boomy side.

This recording effectively shows another aspect of stereo . . . you don't expect to get much directionality at all in this kind of situation, but the ability of stereo to differentiate between sounds and to handle reverb is the important thing. Recording this same program monophonically is a much more difficult task and no matter how you try you will never equal the clarity and articulation afforded by the stereo.

Dupré is truly masterful and his sensitive readings of these works makes all the recording trouble worthwhile.

BEETHOVEN

SYMPHONY #3 ("Eroica")

Vienna Philharmonic Orchestra conducted by Georg Solti. London Stereo CS6145. Price $5.98.

Solti plays this pretty close to the vest and to the score and, as such, the work develops little tension and excitement. There is none of the blazing intensity of a Toscanini or the passionate dedication of a Klemperer . . . which is a shame for the Vienna players perform like angels and the *London* engineers have treated Solti to some beautiful sound.

Everything is very clean and smooth and beautifully balanced, with just the right amount of reverb to give a nicely rounded sense of depth. Good directionality is also a feature as are the record surfaces which are unusually quiet. By far the best sounding "Eroica" on stereo, and if performance values don't bother you, you'll enjoy it.

BEETHOVEN

SYMPHONY #7

Cleveland Orchestra conducted by George Szell. Epic Stereo BC1066. Price $5.98.

A curious performance by Szell, rather deliberate and displaying mannerisms I didn't know the man possessed. Usually Szell is good, solid, and dependable in the Beethoven

repertoire. Who knows . . . maybe he had an off day, but this will not gain favor with purists and it doesn't generate enough excitement to justify its idiosyncrasies.

BRAHMS
CONCERTO FOR VIOLIN AND ORCHESTRA IN D MAJOR
Joseph Szigeti, violinist with London Symphony Orchestra conducted by Herbert Menges. Mercury Stereo SR90225. Price $5.98.

This is the debut of Szigeti on the *Mercury* label and he has chosen well the work for this occasion, the Brahms "Violin Concerto." Now I bow to no one in my admiration for this giant among violinists. I think he is one of the most supremely gifted performers of our time. But alas I think the inroads of time have finally caught up with him.

In general this is a lovely performance that Szigeti spins so lyrically for us. It has grace and elan and a just sense of proportion. But in many places he seems rhythmically insecure and his tone seems to waver. At other times the tone is thin and small in comparison to the orchestra.

The accompaniment, by the way, is excellent and in matters of sound this is a big and imposing sonic edifice. All is quite clean and there is a fine definition and directionality, good depth perspective, and for the most part excellent balance.

DVORAK
SYMPHONY #5 ("New World")
Vienna State Opera Orchestra conducted by Vladimir Golschmann. Vanguard Stereo SRV114SD. Special demo price $2.98.

Here is another of *Vanguard's* terrific demo record buys. I don't know how they turn out so many of these fine records . . . but they must be selling, for there are no angels in the record business. This Dvorak "5th" is characterized by very fast tempi which, while raising the eyebrows of the purists, makes for a lot of excitement. The orchestra plays superbly, but unless I am hearing things, I feel the orchestral strength had been reduced, so that the sound isn't quite as big as on some competing records.

The sound, in general, is great, with nice sonorous brass, bright strings, lovely woodwind sound. The tympani in the first movement are as clear and articulate as I have ever heard in this symphony. So for a fine sounding, exciting recording at a bargain price, look no further . . . this is it!

OPERATIC RECITAL
Joan Sutherland. London Stereo OS-25111. Price $5.98.

Joan Sutherland is typical of the story of the good, hard working singer who has minor roles in the opera and seems to go along for years in this fashion, and then all of a sudden the break comes and . . . voila! . . . a new star flashes across the operatic firmament.

Joan Sutherland's big break came in Feb., 1959 when she scored a smashing success in "Lucia di Lammermoor" at Covent Garden. On this album you can hear two arias from "Lucia," including her now famous "Mad Scene" with which she tore down the house.

Included in the album are several Verdi arias as well and another from "Linda de Chamounix."

A listen to this sumptuous voice quickly convinces of her tremendous talent. The voice is full and powerful with very little tremolo and, in addition to the natural beauty of the voice, it is obvious she knows dramatic projection. If you are interested in opera, here is a new and exciting talent for your pleasure. —50—

The "Big Picture"

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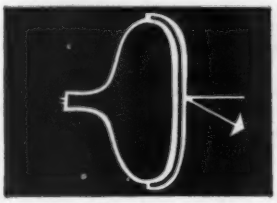
My name is Al—what's yours?

This is my first column, so let me introduce myself.

Al Merriam is the name, Sylvania National Service Manager is my job. I guess you could call me a technician's technician. At any rate, the point of this column is to help you get your job done a little faster, a little easier and a little more profitably.

Frankly, I'm more at home working over a TV chassis than I am working over a typewriter. So the writing may not be fancy. But I promise you'll get the straight facts and plenty of 'em.



For example, in the next few columns, I'll give you some valuable tips on the new Bonded Shield 23″ tube, the new Sylvania control cluster and our new simplified back cover.

Let me hear from you

This column is for you. I want to talk about things that will help you. So if you have any ideas about what topics I should cover, shoot 'em along. The address is below.

Get in on our bulletins and service clinics, too

TV electronics is a fast-moving field, and I'd like to invite all TV service dealers—and hams and hobbyists—to keep up-to-date with the "Big Picture" by subscribing to the Sylvania Service Literature and attending the Sylvania Service Clinics. I know you'll find the clinics an easy way to keep up with the latest in TV and find out what's new with other TV service dealers. Ask your Sylvania television distributor for details on the next clinic session in your area, or write me—Al Merriam, Sylvania Home Electronics Corp., Batavia, N. Y.

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Service Industry News

AN INTERESTING twist in the eternal wrangle over licensing has turned up in Missouri. There are always three sides—at least—in this argument. To one, outright licensing is an absolute necessity. To another, some form of self-policing, such as certification, is preferable. Others see any attempt at regulation as a threat to the health of the service industry.

Long an opponent of government regulation, TEAM of Missouri has succeeded in holding up enforcement of a licensing ordinance passed in Kansas City by supporting litigation against it. To strengthen its position, this association is now considering certification as an alternate. Actually, TEAM President John V. Glass first suggested this stand in 1957.

Although a special committee has been consulting with the Adult Education Division of St. Louis University on this matter for several months, there is still some concern about making sure that benefits outweigh potential disadvantages. "The knottiest problem," reports "TEAM News," "was to make sure any examination would accurately indicate the ability to locate and repair defects in electronic equipment irrespective of the amount of pure theoretical knowledge of the applicant." The contemplated plan would include a character check. A bonding program for TEAM members, to be worked out in conjunction with the certification plan for all, is also being considered.

The curious element in this turn of events is the view toward the role of a certification program. In some quarters (such as in New York State), pro-licensing forces consider certification as a possible stepping stone to full licensing. In Missouri we see a group attempting to use certification to forestall the advent of governmental intervention. As it happens, some of the pro-licensing forces in New York are also opposed to certification, fearing that it may take the place of the licensing they regard as the only ultimate solution! Where does certification actually fit into this confused picture, if at all? Only time can answer that question.

Rewards for Stolen Sets

The pattern of theft from service shops varies widely throughout the nation. In some places, shops are broken into; in others, it is the service vehicle that is subjected to pilfering. Sometimes the criminals concentrate on shop equipment; in other areas TV receivers are the prime targets. There are even some places where the problem doesn't seem to exist at all—and service shops located in such parts of the country may be wondering what the fuss is all about.

Where it occurs, the problem can be quite serious indeed. Witness the drastic action taken by the Indianapolis TV Technicians Assn. It has begun to list models and serial numbers for sets reported stolen in "The Hoosier Test Probe" regularly, in such a form that the listings can be clipped out of the publication and filed systematically in a small looseleaf binder. The first list includes nearly 40 sets. A fund for reward money has been set up so that rewards of $100 or more can be given to those who locate stolen sets. There are doubtless many cases where the recovered set would be worth less than the amount offered for it. This Hoosier group appears quite determined to take effective countermeasures against a growing and alarming problem despite the cost.

Incidentally ITTA's parent (state) group, still gaining strength, has acquired two new affiliates. RTSEA of Logansport and BRTSA of Bloomington have joined the Indiana Electronic Service Assn.

Manufacturers Woo Service

The impressive business-aid program being offered to electronics service dealers by *G-E* (see last month's "Service Industry News"), rather than being an isolated project, appears to be part of a general step-up being made by tube manufacturers in the campaign to win service friends. Furthermore, the emphasis in current efforts is on business and shop management, rather than technical assistance, reflecting the service industry's own appraisal of its present areas of strength and weakness.

RCA's program for store improvement, available through authorized tube distributors, includes 35 business and service aids, intended to attract new business, make maximum use of existing space, and increase efficiency. Among the aids are illuminated action signs, pressure-sensitive shelf strips to identify tube types, a sturdy bench unit for the service area, wash-and-wear uniforms, a tube caddy, a light for display in the service vehicle that reads "Television Technician on Call," panel signs for trucks, decals, and a "Store Improvement Guide" that explains the program.

Authorized *Sylvania* distributors are offering a 12-lesson correspondence course on business techniques and practices, designed to help the service

dealer realize maximum profit from his sales and service techniques. The course includes information on buying, pricing, inventory, insurance, taxes, advertising, and customer relations. The program is published by the *Radio-Television Training Association.*

Kansas Convention and Show

In conjunction with its annual convention, TESA of Kansas is staging its second Mid-Continent Electronic Show at the Lamer Hotel in Salina, Kansas, June 17, 18, and 19. The use of two large areas in the hotel for the event this year permits an added feature. One area will be used to display exhibits of interest to technicians and shop owners, as well as for convention meetings and the banquet. The other area will be open to the general public. The state group will have its own booth in the latter space, which will also feature the latest in TV and stereo.

The Kansas state group has also approved a disability insurance plan for which all members in good standing and their employees are eligible.

Tri-State Telerama

The fourth annual service convention and Telerama to be sponsored by the Tri-State Council of TV Service Associations will take place at the Shelburne Hotel and Empress Motel in Atlantic City, N. J., June 24, 25, and 26. Manufacturers are being invited to display their products and services to the visiting technicians from the area covered by this group, which includes Delaware, New Jersey, and Eastern Pennsylvania. Delegates from other states are also expected to attend.

Technician Registration

"ETG News," published by the Boston Chapter of the Massachusetts Guild, is pleased with the fact that service technicians in Fall River, Mass. are now being required to pay a $5 registration fee under a local ordinance. The effect of this ordinance is to make certain that service businesses pay local property taxes and keep records pertaining to state and federal taxes. This measure is being regarded as a step in the direction of licensing and related legislation throughout the state.

California Apprenticeship

With the appointment of Al Thomas of Stockton as head of its apprenticeship committee, the California State Electronics Association is forging ahead in its plan to establish an electronic service training program in collaboration with state education figures. Tentative target date for the completed plan is the Fall semester this year.

Milwaukee Officers, 1960

Recently elected officers of TESA of Milwaukee for this year have been announced. They include Larry Dorst, president; Arthur Nelson, vice-president; Daniel Smith, treasurer; and Ed Bruning, NATESA director. —30—

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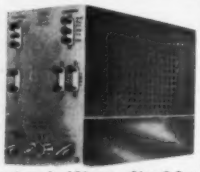

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Indoor Antenna—Outdoor Design

"Printed-circuit" unit for hidden installation is comparison-tested against outdoor receptors.

DURING the decade and a half of the television era, there has been a host of indoor antennas for which various manufacturers have claimed performance equal to that of standard outdoor units. Despite a long history of disappointments in realizing that goal (see "Line-Cord Antennas: Fact and Fiction," ELECTRONICS WORLD, March), there is some evidence that the aim has been achieved. *Jerrold Electronics Corp.* is offering an intriguing antenna design for indoor use that also overcomes other objections to indoor units. Adaptable to concealment, it presents no appearance problems. Since it will require no more adjustment in use than conventional, non-rotatable outdoor units, it will not wear out.

The entire antenna is incorporated on a flat, flexible mat six feet wide and less than two and a half feet deep. This "Magic Carpet" (Model MK-1) has the antenna configuration silvered on with a printed-circuit technique. Starting point for the design was the conical antenna, one of the most popular throughout the country. With some changes this design, which is essentially a broad-banded dipole, was projected onto a flat plane so that it could be deposited on the "carpet."

Across the forward portion of the antenna (open end of the *V*, as shown below) two "bars" may be seen, at right angles to arriving signals. On the low v.h.f. band, these bars help to maintain impedance match. On the high channels, the bars act as a director, increasing forward gain and minimizing the break-up of the polar-response pattern common to most conicals on the high band.

Maximum voltage standing-wave ratio is reported as 1.4 on any v.h.f. TV frequency. Maximum v.s.w.r. at any point between 54 and 216 mc. is 1.7, making the antenna useful for FM reception. Gain characteristics across all frequencies are very close to those of standard outdoor conicals, with a better forward characteristic reported for the "Magic Carpet" on the upper channels, as noted. All measurements for the MK-1 were made with the unit mounted on a wooden platform, to simulate the actual environment in which the antenna will be used.

The antenna may be placed in an unfinished attic or crawl space, built into spaces between floors and ceilings, put on the ceiling or floor of a closet, or hidden under a rug. It is oriented in conventional fashion, connected to a standard 300-ohm line, to which it is closely matched, and then forgotten. Obviously it should be kept away from metal and other objects that may load it and impair performance. For this reason, it is not recommended in large buildings that are built around metal frameworks.

Recently demonstrated in a new development of Levitt homes under construction, 30 miles away from TV transmitters, the MK-1 impressed the builder to the point that he is building "Magic Carpets" into all homes in this colony. Other builders in other areas have also placed orders. Because of its size and shape, it is difficult to "null" this unit by body movement. In other words, people moving about the room in which the antenna is located under a rug, even when they are standing directly over it, have little effect on performance.

Jerrold is now experimenting with "add-on" director and reflector carpet units for fringe use. Meanwhile the basic MK-1, going into mass production at this writing, should be available by the time this story is read. Although a definite list price has not been announced, it is expected to be "under ten dollars." —30—

Permanent installation: a "Magic Carpet" being stapled to joists in the attic.

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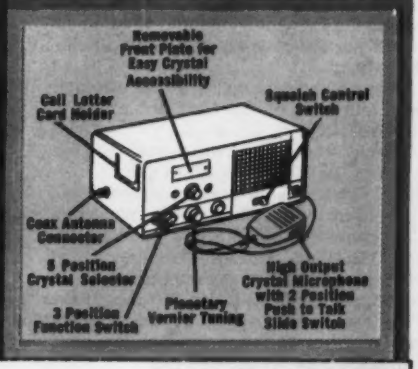
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Construction details on a broadband, high gain antenna with about 8 db gain from 30 to 300 mc.; useful for ham and TV reception.

The Log-Periodic Antenna

By **CALVIN R. GRAF,** WSLFM

THE logarithmically periodic antenna may be the answer to the antenna man's dream because it is broadband, omni-directional, and exhibits high gain. The log-periodic is so named because its electrical characteristics are repeated periodically as the logarithm of the frequency. Practically, it has a ten-to-one bandwidth; in theory, the bandwidth is almost infinite.

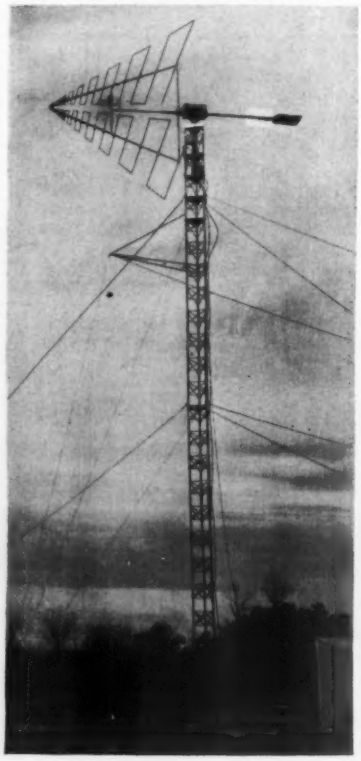
Gain is about 8 db above an isotropic radiator, roughly equal to that of a three-element yagi. Additional experimentation by the antenna industry will no doubt eventually result in gains of 10-13 db, about that of a 5- to 10-element yagi.

What does this mean to the average amateur? It means that one antenna (shown in Fig. 5), about the size of stacked three-element yagis for ten meters, will be able to do the following: Cover all of the ten-meter band, the 40-mc. Sputniks, the 50-mc. band, TV channels 2-6, the FM band 88-108 mc., the U.S. satellite frequencies at 108 mc., all of the two-meter band, TV channels 7-13, and the 220-mc. band. The rest of the useful bandwidth of the antenna would take in part of the u.h.f. aircraft band of 225-400 mc.

To give you an idea of the space saved, it would take 67 three-element yagis, each 4 mc. wide, to do the same job! And that is quite an antenna farm, even for the Texas boys!

This article will give a few of the parameters which describe the electrical operation of the log-periodic. Detailed design information can be found in the many articles which have appeared in various publications.[1,2,3,4] Fig. 2 is a diagram of one of the sides which go to make up the antenna. Two such sides are spaced a certain angle, such as a bow-tie antenna almost bent back on itself, and fed at the vertices of the triangles by means of coax line run up one of the booms (unbalanced) or by 150-ohm parallel-wire line at the apex (balanced). A stepped-exponential line within and bonded to the lower boom transforms from 50 ohms up to the 150-ohm feedpoint of the antenna. See Fig. 3.

Fig. 1. V.h.f. log-periodic array mounted on tower with coverage from 30-180 mc.



The log-periodic antenna, which has yet to be explained mathematically, appears to be an unusual animal. While there are many possible configurations of the basic unit of zig-zag elements placed on a boom, the most popular one at the present time is that shown in Fig. 5. The unusual part comes from the fact that energy is fed directly to each boom (insulated from each other at the feedpoint), yet it is the cross zig-zag elements (all connected to the boom electrically and mechanically) which do the radiating (as in a yagi). The phase point of the array moves toward the feedpoint as the frequency increases. As the frequency goes up, fewer of the larger elements are used and beamwidth and gain remain almost constant.

Other configurations of the array in-

clude two planer log structures placed at right angles to each other to provide a horizontally polarized omnidirectional pattern. Prior to the log antenna, there was no broadband horizontally polarized antenna, such as the discone for vertical polarization. The elements can also be arranged to produce circular polarization of either rotation sense.

A point is reached where the log-periodic does not provide sufficient gain in a system and it is more practical to go to a different type of structure, even though the log might continue to work to a much higher frequency. In this case, a log can be used to feed a parabolic reflector. It used to be quite a task to change the narrow-band feeds of a large array such as a 28-foot dish when desiring a different frequency coverage. However, Isbell reports[5] using one log feed to cover 105 to 430 mc. Printed-circuit techniques can be used to form the feed when the frequency approaches several thousand megacycles.

Bandwidth of an antenna has to be related to v.s.w.r., gain, or polarization. Most high-gain antennas have narrow useful bandwidths as determined by v.s.w.r. or gain uniformity. A yagi is performing well if it can crank out 5-7% bandwidth. A practical log structure will keep running long after it has passed a 10 to 1 frequency ratio. The v.s.w.r. of the log is generally less than 2:1 across this band of frequencies. At this point, the mismatch loss is just .5 db.

High-frequency log antennas are available[6] which cover 6.5 to 60 mc. in one structure. Think of the number of 3-element yagis required to cover this bandwidth. Fig. 1 shows a v.h.f. log-periodic array designed for polarization change, using a motor, mounted atop a 60 foot tower.[7]

Close modeling of the mechanical parts is essential for good electrical operation of the antenna. The longest element is about a half-wavelength for the lowest frequency and the shortest element is about ⅜ wavelength at the highest frequency. The element diameters must be properly tapered to assure smooth operation and become smaller as the frequency goes up. Operation at the high end is dependent on good modeling techniques of the apex of the triangle sides as this is the portion which does the radiating.

Fig. 4 shows the parameters which determine response of the log-periodic. Since there are so many variables, it is best to use a known set of values and reproduce the array without resorting to elaborate test methods which are generally not available to everyone. Directivity is in the direction in which the structure points—as that of an arrowhead.

Dimensions for the individual sides are shown in Fig. 2. The reducing process is continued toward the apex where the tubing becomes too small to work. At this point a solid piece of metal can be used, or a triangle made of the tubing, as shown in Fig. 5. The

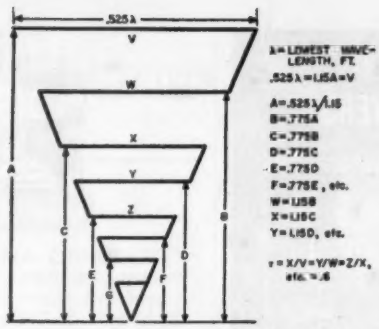


Fig. 2. Dimensions used in designing log-periodic antenna. Refer to text.

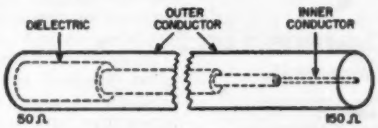


Fig. 3. Center conductor of coax line stepped to provide impedance change from 50 to 150 ohms. Line runs up boom of lower antenna element. The more steps employed, the smoother the transition.

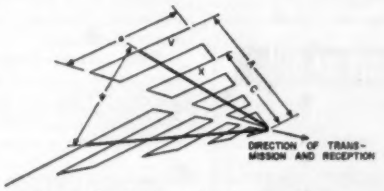


Fig. 4. Parameters of antenna with $\tau = C/A = X/V$. Antenna is fed at apex of triangles at 150-ohm point. Note that one side of the antenna is reversed.

steps would be as follows: (1) determine the lowest frequency to be covered, (2) length of the longest element establishes low-frequency end of array, make this .525λ, (3) calculate the length of each element and its distance from the apex (starting with the longest) using the following relations: length of each element is 1.15 its distance from the apex; distance from the apex to each element is .775 the distance of the next longer element, (4) establish value of α (60 degrees is a good value), (5) establish a value of τ, may be .4 to .707 (.6 is a good value), (6) establish large angle ψ between the two antenna sections for highest gain (45 to 60 degrees is good).

With these parameters, gain would be 8 db over isotropic and front-to-back ratio would be better than approximately 10 db.

Additional experimentation by the industry may yield results which allow a single side to be fed and yet produce the same broadband results. In this case the array would be horizontal and look like a single yagi, occupying less space than the present design.

Much of the credit for the development and popularization of the log-periodic should go to DuHamel of *Collins Radio Company* and Isbell of the University of Illinois who did much of the basic design and modeling of the array.

The log-periodic antenna will probably become increasingly popular in the future. There is no doubt that Minerva was guilty of understatement when he said[3]: "Antennas of this nature represent a major advancement in the antenna field. It is felt that in a short period of time antennas of this kind will be located all over the world, and will be satisfying a great many requirements."

The author wishes to express his appreciation to Justin R. Duncan for his advice and comments during the preparation of this article.

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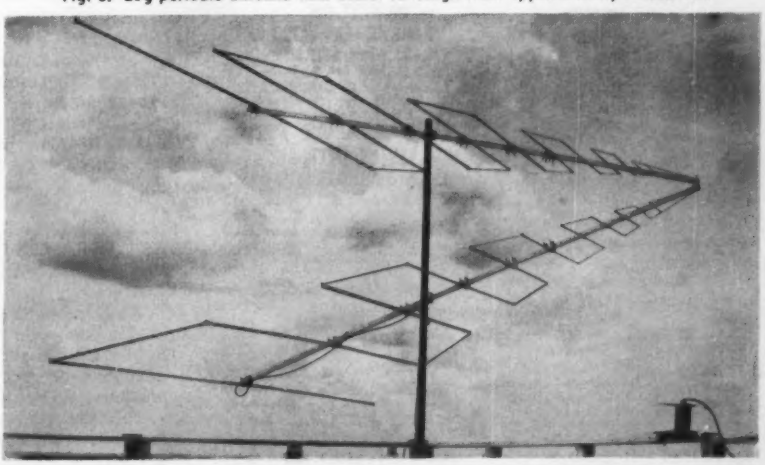
6. *Collins Radio Co., Cedar Rapids, Iowa*
7. *All Products Co., Mineral Wells, Texas*

—30—

Fig. 5. Log-periodic antenna with useful coverage from approximately 30-300 mc.



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Here is the 1960 edition of the amateur's "bible" in new and expanded form. The sections on the theory of radio-communications have been brought up to date and the material on the construction of various items of ham gear has been revised to include a number of new designs.

In addition to providing construction details on equipment designed for all classes of amateur service, special methods of communication, including sideband, radioteletypewriter, and mobile, are covered in some detail.

The chapter on vacuum-tube characteristics, always one of the most valuable sections of the Handbook, has been brought up to date and expanded to include newly developed tubes.

The catalogue section features the equipment and components of a number of leading makers of ham equipment with emphasis on complete product specifications for reference purposes.

The sixteen-page index, which completes the volume, facilitates locating the specific circuit or subject the user is seeking. Like its predecessor volumes this new Handbook provides both Novice and experienced amateur radio operators with a compact, one-book ham shack "library."

* * *

"MEDICAL ELECTRONICS" by Edward J. Bukstein. Published by *Frederick Ungar Publishing Co.*, New York. 164 pages. Price $3.50.

Although this volume has been written primarily for the electronic technician who may be called upon to service the medical electronic equipment discussed in the text, this book should also be of interest to medical students, technologists, nurses, physicians, surgeons, and medical researchers.

The author covers strip chart recorders, the recording of biological potentials, recording of nonelectrical physiological phenomena, radio-isotopes,, x-ray apparatus, diathermy and inductothermy, electrodiagnosis, electrotherapy, and electrosurgery, and ultrasonics.

In each instance the author has written introductory material explaining the function and application of the equipment covered and listing the parameters or operating tolerances of such gear. The various general types of units are discussed along with commercial examples of such equipment. Partial schematics, line drawings, graphs, and photographs are used lavishly to illustrate the text material. Each chapter carries a specialized bibliography for those wishing a more comprehensive treatment of a particular subject.

Technicians accustomed to servicing television receivers should have no difficulty in making the transition to the servicing of the medical electronic equipment covered in this volume.

* * *

"BASICS OF FRACTIONAL HORSEPOWER MOTORS AND REPAIR" by Gerald Schweitzer. Published by *John F. Rider Publisher, Inc.*, New York, 162 pages. Price $3.90. Soft cover.

While all of the types of motors discussed by the author in this book aren't encountered by the radio-TV technician in the course of his job, many such units used in phonographs, tape recorders, antenna rotators, etc. are "bread-and butter" items to the service shop.

The text material is divided into thirteen chapters and, in addition to discussing the various types of motors, covers testing, care and maintenance, control devices, and motor

protective devices. A glossary of terms and a comprehensive index complete the book.

Like many of the texts from this publisher, the book is so lavishly illustrated by line drawings, pictorials, and photographs that it lends itself admirably to the "do-it-yourself" seeker after knowledge as well as in more formal classroom presentation of the subject.

* * *

"COMPUTERS AND HOW THEY WORK" by James D. Fahnestock. Published by *Ziff-Davis Publishing Company*, New York. 224 pages. Price $4.95.

Here is a book for the intelligent layman, the businessman, the computer technician, or those wishing to enter the computer field. Written in non-technical language and employing familiar analogies, the author covers the function of electronic computers, computer language, computer arithmetic, digital-computer programming, computer logic circuitry, how men and machines communicate, how computers "remember," analog computers, data-acquisition systems, and typical computer systems.

The text is lavishly illustrated with line drawings, schematics, and photographs of various commercial units and their components. No pre-requisite training or experience in electronics is demanded of the reader hence the book is entirely suitable for anyone interested in or who works with computer equipment.

* * *

"SCIENCE STUDY SERIES" published by *Doubleday & Company, Inc.*, Garden City, N. Y. Four volumes (Nos. 7, 8, 9, and 10). Soft binding.

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As was the case with the earlier volumes in the series, these books have been prepared and produced with unusual care and with close attention to detail. In each instance the authors have been selected with rare discrimination not only for their knowledge of their subjects but for their ability to transmit their knowledge to the layman in clear, non-technical language.

All of the books are lavishly illustrated—many of them contain color plates in addition to the schematics, line drawings, and photographs. Again, we would like to congratulate the publisher for participating in this unusual educational program which brings scientific knowledge within the mental and financial reach of a large segment of the population. -30-

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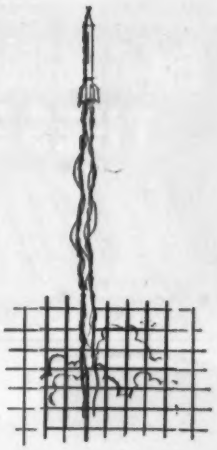


Advance your career in the most critical field of tomorrow: integrated DATA PROCESSING for military weapons systems at BURROUGHS, Military Field Service Division. Participate in challenging work on important long range ATLAS and SAGE programs.

SYSTEMS ENGINEERS

To conduct simulated operational tests and evaluation studies related to the functional analysis of weapons guidance control systems. Candidates should possess BSEE with experience in radar, digital computer techniques, communications or related fields.

FIELD ENGINEERS

For assignments involving direct supervision of field teams in the installation and maintenance of data processing equipment. Requires minimum of 10 years' experience and willingness to relocate.

JUNIOR ENGINEERS

Recent college graduates to take part in a formal training program at full salary (no experience required). Upon completion you will be assigned to either the Field Operations Department, Engineering Department or our recently established Field Test and Development Department in accordance with the abilities and aptitudes evidenced during the training program.

The above positions carry Burroughs' exceptional benefit programs. Inquiries are invited from qualified candidates. Please write Mr. R. F. Johnson, Dept. 2482, Burroughs Corporation, Military Field Service Division, Burroughs Drive, Radnor, Penna. (a suburb of Philadelphia).

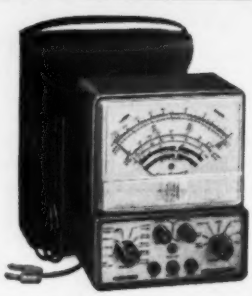
Burroughs Corporation

"NEW DIMENSIONS/in computation for military systems"

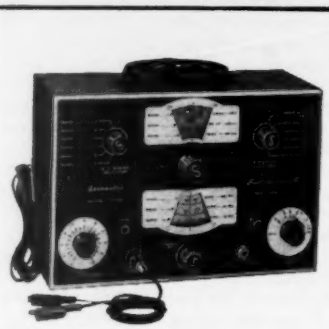
EXAMINE ANY OF THESE TESTERS *BEFORE* YOU BUY!!

Yes, we offer to ship *at our risk* one or more of the testers described on these pages.

Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months.



Terms: $8.50 after 10 day trial, then $6.00 per month for 5 months.



Terms: $11.50 after 10 day trial, then $6.00 per month for 6 months.

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Compare it to any peak-to-peak V. T. V. M. made by any other manufacturer at any price!

• Extra large meter scale enables us to print all calibrations in large easy-to-read type.

• Employs a 12AU7 as D. C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability. • Meter is virtually burn-out proof. The sensitive 400 micro-ampere meter is isolated from the measuring circuit by a balanced push-pull amplifier. • Uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

AS AN AC VOLTMETER: Measures RMS values if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

SPECIFICATIONS

• **DC VOLTS**—0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS (RMS)**—0 to 3/15/75/150/300/750/1,500 volts. • **AC VOLTS (Peak to Peak)**—0 to 8/40/200/400/800/2,000 volts.

• **ELECTRONIC OHMMETER**—0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms. • **DECIBELS:** —10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • **ZERO CENTER METER**—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Comes complete with operating instructions, probe, leads, and streamlined carrying case. Operates on 110-120 volt 60 cycle. Only **$42.50**

SUPERIOR'S NEW MODEL 79

SUPER-METER

WITH NEW 6" FULL-VIEW METER

A combination VOLT-OHM MILLIAMMETER

Plus CAPACITY, REACTANCE, INDUCTANCE & DECIBEL MEASUREMENTS

Also Tests SELENIUM & SILICON RECTIFIERS, SILICON & GERMANIUM DIODES

The model 79 represents 20 years of continuous experience in the design and production of SUPER-METERS, an exclusive SICO development. It includes not only every circuit improvement perfected in 20 years of specialization but, in addition includes those services which are "musts" for properly servicing the ever-increasing number of new components used in all phases of today's electronic production. For example with the Model 79 SUPER-METER you can measure the quality of selenium and silicon rectifiers and all types of diodes—components which have come into common use only within the past five years, and because this latest SUPER-METER necessarily required extra meter scale, SICO used its new full-view 6-inch meter.

SPECIFICATIONS:

• **D.C. VOLTS:** 0 to 7.5/15/75/150/750/1,500. • **A.C. VOLTS:** 0 to 15/30/150/300/1,500/3,000 • **D.C. CURRENT:** 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes • **RESISTANCE:** 0 to 1,000/100,000 Ohms, 0 to 10 Megohms. • **CAPACITY:** .001 to 1 Mfd., 1 to 50 Mfd. • **REACTANCE:** 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms. • **INDUCTANCE:** .15 to 7 Henries, 7 to 7,000 Henries. • **DECIBELS:** —6 to + 18, + 14 to + 38, + 34 to + 58. The following components are all tested for QUALITY at appropriate test potentials. Two separate BAD-GOOD scales on the meter are used for direct readings. **All Electrolytic Condensers** from 1 MFD to 1000 MFD. **All Germanium Diodes. All Selenium Rectifiers. All Silicon Diodes. All Silicon Rectifiers.**

Model 79 comes complete with operating instructions, test leads, and streamlined carrying case. Use it on the bench—use it on calls. Only **$38.50**

SUPERIOR'S NEW MODEL TV-50A

GENOMETER

7 Signal Generators in One!

- R.F. Signal Generator for A.M.
- R.F. Signal Generator for F.M.
- Audio Frequency Generator
- Marker Generator
- Bar Generator
- Color Dot Pattern Generator
- Cross Hatch Generator

This Versatile All-Inclusive GENERATOR Provides ALL the Outputs for servicing:

• A.M. RADIO • BLACK AND WHITE TV
• F.M. RADIO • COLOR TV • AMPLIFIERS

R. F. SIGNAL GENERATOR: 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: Provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

MARKER GENERATOR: The following markers are provided: 189 Kc.; 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc is the color burst frequency.)

BAR GENERATOR: Pattern consists of 4 to 16 horizontal bars or 7 to 20 vertical bars.

DOT PATTERN GENERATOR (FOR COLOR TV): The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

CROSS HATCH GENERATOR: The pattern consists of non-shifting horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

The Model TV-50A comes complete with shielded leads and operating instructions. Only **$47.50**

WHAT IF YOU'RE NOT COMPLETELY SATISFIED?

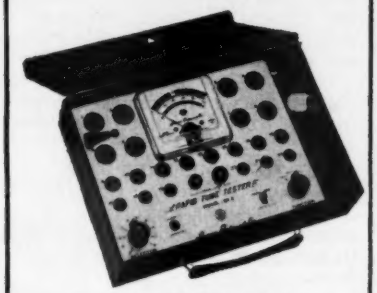
You are privileged to return any goods purchased from us—no explanation of any kind necessary. Just return our goods after 10 day free examination and we automatically cancel our invoice. *Request for permission to return is never required.*

NO CONTRACT TO SIGN
CO-MAKERS
EMPLOYER NOTIFICATION

The simple order authorization included in this offer is all you sign. We ask only that you promise to pay for or return the goods we ship in good faith.

EXAMINE ANY ITEM YOU SELECT IN THE PRIVACY OF YOUR OWN HOME

Then if completely satisfied pay on the interest-free terms plainly specified. When we say interest-free we mean not one penny added for "interest" for "finance" for "credit-checking" or for "carrying charges." The net price of each tester is plainly marked in our ads—that is all you pay except for parcel post or other transportation charges we may prepay.



Terms: $6.50 after 10 day trial, then $6.00 monthly for 5 months.

Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months.

Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL 82A

A truly do-it-yourself type

TUBE TESTER

TEST ANY TUBE IN 10 SECONDS FLAT!

1. Turn the filament selector switch to position specified.
2. Insert tube into a numbered socket as designated on our chart (over 600 types included).
3. Press down the quality button—

THAT'S ALL! Read emission quality direct on bad-good meter scale.

• Tests over 600 tube types. • Tests OZ4 and other gas-filled tubes • Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings. • Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence. • Dual Scale meter permit testing of low current tubes. • 7 and 9 pin straighteners mounted on panel. • All sections of multi-element tubes tested simultaneously. • Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82A will outperform similar looking units which sell for much more—and as proof, we offer to ship it on our examine before you buy policy.

Primarily, the difference between the conventional tube tester and the multi-socket type is that in the latter, the use of an added number of specific sockets (for example, in Model 82A the noval is duplicated eight times) permits elimination of element switches thus reducing testing time and possibly of incorrect switch readings.

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch—THAT'S ALL! Read quality on meter. Inter-element leakage, if any, indicates automatically.

Model 82A comes housed in handsome, portable, Saddle-Stitched Texon case. Only **$36.50**

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL

TUBE TESTER

• Tests all tubes, including 4, 5, 6, 7, Octal, Lockin, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Subminars, Proximity Fuse Types, etc.

• Uses the new self-cleaning Lever Action Switches for individual element testing. **All elements are numbered according to pin-number in the RMA base numbering system.** Model TW-11 does not use combination type sockets. Instead individual sockets are used for each type of tube. **Thus it is impossible to damage a tube by inserting it in the wrong socket.**

• Free-moving built-in roll chart provides complete data for all tubes. Printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier detects microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES

• Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

Comes housed in a handsome, portable Saddle Stitched Texon case. Only **$47.50**

SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

Tests and Rejuvenates ALL PICTURE TUBES

ALL BLACK AND WHITE TUBES

From 50 degree to 110 degree types —from 8" to 30" types.

ALL COLOR TUBES

Test ALL picture tubes—in the carton—out of the carton—in the set!

• Model 83 is not simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes. • Model 83 provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types. • Model 83 employs a 4" air-damped meter with quality and calibrated scales. • Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode. • Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition. • Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a selective low voltage uniformly to assure increased life with no danger of cathode damage.

Housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only **$38.50**

Try any of the instruments on this or the facing page for 10 days before you buy. If completely satisfied **then** send down payment and pay balance as indicated on coupon. **No Interest or Finance Charges Added!** If not completely satisfied return unit to us, no explanation necessary.

MOSS ELECTRONIC, INC.
Dept D-748, 3849 Tenth Ave., New York 34, N. Y.

Please send me the units checked on approval. If completely satisfied I will pay on the terms specified with no interest or finance charges added. Otherwise, I will return after a 10 day trial positively canceling all further obligations.

Name .....

Address .....

City .....Zone ....State .....

- ☐ **Model 77 .....Total Price $42.50 $12.50 within 10 days. Balance $6.00 monthly for 5 months.**
- ☐ **Model 79 .....Total Price $38.50 $8.50 within 10 days. Balance $6.00 monthly for 5 months.**
- ☐ **Model TV-50A ..Total Price $47.50 $11.50 within 10 days. Balance $6.00 monthly for 6 months.**
- ☐ **Model 82A .....Total Price $36.50 $6.50 within 10 days. Balance $6.00 monthly for 5 months.**
- ☐ **Model TW-11 ...Total Price $47.50 $11.50 within 10 days. Balance $6.00 monthly for 6 months.**
- ☐ **Model 83 .....Total Price $38.50 $8.50 within 10 days. Balance $6.00 monthly for 5 months.**

All prices Net, F.O.B., N.Y.C.
Export Division: Rocke International Corp., 13 East 40th St., New York 16, N. Y.

Advance **STEPPING RELAYS!**

Resettable 12 VDC coils, 3 deck, 10 pos. w/add. 1A & 1B contact at reset position 16 deck, 22 position $8.95 $22.50

POWER SUPPLY KIT!

Pri. 115V, 60 Cy. Sec., 400-0-400 @ 200 ma., 6.3V @ 4 amp., 5V @ 2 amp., 8 hy choke, (2) 8 mfd. 600 V oil condensers .....

M A R Power Supply

115 V. 60 cyc. input 12-14 VDC, 2 Amp. output filtered and fully housed. SPECIAL $8.95

★★ POWER TRANSFORMERS ★★

117 V. Pri., 800 VCT., 200 Ma.; 6.3 V., 5 Amps; 5 V., 2 Amps $4.95

720 VCT., 200 Ma.; 12.6 V., 3 Amps; 6.3 V., 10 Amps; 5 V., 3 Amps $3.95

1000 VCT 200 ma.; 6.3 V @ 4 amps; 5V @ 3 amps $6.45

1200 VCT, 600 ma; 6.3 V @ 30 amps, 5V @ 12 amps, Xtra 6.3 & 5V windings $12.50

—TRANSFORMER Buys!!—

ALL WITH 115 VOLT PRIMARY

6.3 V. SEC. 1 Amp. $1.25	6.3 V SEC. 4 Amp.. 2.29
110 OR 220 PRI 5-7-9 V SEC. 3 Amp 1.59 (can be used as 110/220 step up/down tsfm)	12 V SEC. 2 Amp.. 1.49
	6.3 V SEC. 15 Amp CT 3.95
	12 V SEC. 1 Amp.. 1.19
	24 V 150 VA..... 2.69
24V SEC 1 Amp.....	1.59
Step up/down Transformer 110 V-220 V 10 Amp.	9.95
Primary 115, sec. 6 V-7 V-8 V, 75 VA.....	2.75
Plate 3100 VCT 300 Ma.....	17.75

★★ RELAYS! RELAYS! RELAYS! ★★

110 VAC DPDT....$2.75	Sigma 3,200-ohm SPDT..... 2.45
110 VAC DPDT, Ceramic-Leach 3.45	24 VAC SPDT Sigma 41-F—$1.35; w/ tsfm for 110 VAC 1.65
12 VDC DPDT..... 1.35	115 VAC SPST, dbl. brk. 25 amp cont. 150 VA..... 1.89
24 VDC, 4 PDT... 3.95	24 VAC DPDT..... 1.69
24 VDC, DPDT w/ dust cover..... 2.45	24 VAC 3 PDT, S-D 2.25
6 VDC SPDT..... 1.35	

LARGE STOCK AC, DC RELAYS!

SOLENOIDS

115V 60 cyc. cont. duty, 22 lb. pull.....ea. $5.75
18 lb. pull....ea. $4.75 8 lb. pull....ea. 2.30

Chokes—Fully Cased

6 hy. 100 Ma....$1.09	
10 hy. 100 Ma.... 1.75	
22 hy. 100 Ma.... 2.59	
20 hy. 110 Ma.... 2.10	
8 hy. 200 Ma.... 1.85	
10 hy. 350 Ma.... 3.95	
20 hy. 300 Ma.... 7.95	

TELEPHONE HEADSET

Murdock model H-58U high. imp. hnd. Boxed. SPECIAL $3.69

3 or 4 Wire Telephone Coiled Cords (or specify)
Hvy. duty. Each ... 99c (6 for $5.50)

RG CO-AX CABLE—UG CONNECTORS

8/U. 100-ft. lengths	$7.75
58/U. 100-ft. lengths	4.75
59/U 100-ft. lengths	4.75
50 239 connectors	3 for 1.25
PL 259A connectors	3 for 1.25
M 359A connectors	3 for 1.15
Adaptors for 58/U or 59/U	22¢ ea.

OIL CONDENSER BARGAINS

3 x 8 Mfd. 500 V.	$2.75	3 Mfd 1500 VDC	3.25
2 Mfd 600 VDC	.45	8 Mfd 1500 VDC	3.25
4 Mfd 600 VDC	.69	3 Mfd 2000 VDC	2.75
8 Mfd 600 VDC	.90	2 Mfd 2500 VDC	2.25
10 Mfd 600 VDC	1.10	1 Mfd 3000 VDC	1.75
15 Mfd 600 VDC	1.90	3 Mfd 4000 VDC	7.50
16 Mfd 600 VDC	1.75	1 Mfd 5000 VDC	4.10
25 Mfd 600 VDC	3.25	2 Mfd 5000 VDC	8.75
1 Mfd 1000 VDC	.55	2 Mfd 6000 VDC	12.75
2 Mfd 1000 VDC	.69	2 Mfd 10000 VDC	16.95
15 Mfd 1000 VDC	2.95	1 Mfd 12500 VDC	18.95
4 Mfd 1500 VDC	1.95		

ELECTROLYTICS

1500 mfd., 80V $1.85
8000 mfd., 25V 3.25
2000 mfd., 15V ..... .79
SPECIAL 10 for $6.00

JENNINGS VACUUM CAPACITOR

25 mmfd., 10 KV $7.19

S-A-L-E! PANEL METERS!

1" METERS		0-100 Mills DC	3.45
0-500 Micro-amps	3.50	0-200 Mills DC	3.95
2" METERS		0-250 Mills DC	3.95
0-1 ma. w/ shunt	3.80	0-5 Amp AC (scale marked 0-150)	3.25
0-100 ma. RF, w/ shunt	3.25	0-15 Amp RF	3.95
0-3 amps RF	3.25	0-30 Amp RF	3.95
0-5 amp DC	3.25	0-75 Amps AC	4.25
0-15 amp DC	3.25	0-1 Mill (scale 0-80)	4.25
0-15 VAC	3.25	200-0-200 VDC	3.95
0-30 Ma DC	3.25	0-1.5 KV DC w/shunt	6.95
0-500 VAC	3.25	0-3.5 KV DC w/shunt	6.95
0-7.5 VDC	3.25	0-300 Amps DC, with shunt	5.95
3" METERS		—10.0 to + 6DB	5.95
0-100 Microamps	5.95	RUNNING TIME METERS:	
0-7.5 VAC	3.25	0-9999 JBT, 230V.	9.50
0-15 VAC	3.95	Comb w/freq. meter, JBT, 110 VAC	17.95
0-150 VAC	4.45	Fram freq. meter 400 cyc.	9.95
0-150 VDC	4.25		
0-15 Ma. DC	3.95		
0-1 Mill (scale 0-80)	4.25		
0-100 Mills AC	3.95		
0-1 Mill DC	4.45		
0-5 Mils DC	3.25		

★★ SELENIUM RECTIFIERS ★★

—FULL WAVE BRIDGE—

130/110 VAC input		30/24 VAC input	
150 mills	$1.25	½ Amp	$1.19
200 mills	1.75	2 Amp	2.15
300 mills	2.50	5 Amp	4.95
500 mills	3.50	7.5 Amp	6.95
12 Amps	19.75	10 Amp	7.50
		20 Amp	12.95

GERMANIUM RECTIFIERS

30/24V input, 30 amps $21.95
SILICON—500 V—500 Ma. ..... $1.09 ea. ($5 for $5.00)

AN 131-A ANTENNA

10 ft. 6 in. collapsible to 17" sections 89c

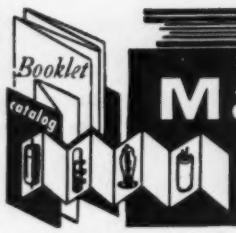
SELSYNS

115V, 60 cyc., high torque ..ea. $5.95 (pair $10.50)

Min. Order $3.00—25% with order F.O.B. New York
10 DAY GUAR. PRICE OF MDSE. ONLY

Advance Electronics

6 West Broadway • New York 7, N. Y. • REctor 2-0270



Manufacturers' Literature

FRAME-GRID TUBES

The Semiconductor and Special Purpose Tube Division of *Amperex Electronic Corp.*, 230 Duffy Ave., Hicksville, N. Y. has just issued a 13-page booklet which describes in detail how frame-grid tubes for TV applications are made and lists specifications on these tubes.

The booklet points out that the frame grid has enabled engineers to design and construct electronic tubes with higher transconductances, lower noise, less microphonics, greater reliability, and smaller spread in characteristics than heretofore possible.

For further information on the tubes themselves and a copy of *"Amperex* Frame Grid Tubes for TV," write direct to the manufacturer on your company letterhead.

SYLVANIA TUBE BOOKLET

Sylvania Electric Products Inc. has issued a new 24-page booklet entitled "A New Era of *Sylvania* Electronic Tubes" which is available from the company at 1100 Main Street, Buffalo, New York.

In addition to describing prototypes of the electron tubes of tomorrow, the booklet also contains information on new designs in tube parts, latest automation concepts, up-to-date finishing systems, and a special section on new plant ideas.

EIA STANDARDS INDEX

The Electronic Industries Association, 11 W. 42nd Street, New York, N. Y. has issued a new listing of "Recommended Standards, Specifications, and Engineering Publications" which covers currently available material.

In addition to listing the publication number, the index includes title of the standard, date of issue, and price. All of the listed standards are available from the EIA Engineering Office at Room 650 at the above address. Since payment must accompany orders, those interested in obtaining standards are advised to write for a copy of this index first.

STANCOR TRANSFORMERS

Chicago Standard Transformer Corporation, 3501 W. Addison St., Chicago 18, Ill. is now offering copies of its new 36-page "Stancor" catalogue covering over 750 transformers for industrial, communications, and radio-TV applications.

A new indexing system makes it extremely easy to locate the required transformer. Complete electrical and physical specifications are given for all units listed.

Among the new items appearing for the first time are a group of high-current filament chokes and filament transformers with multiple secondaries. Over 50 transformers for transistor applications, with frequency response and impedance characteristic curves, are listed.

Copies of this catalogues are available either from the company's distributors or from the manufacturer direct.

TEST EQUIPMENT DATA

Century Electronics Co., Inc., 111 Roosevelt Ave., Mineola, N. Y. has issued a two-color data sheet covering its line of test equipment for the service field.

Complete performance and electrical specifications are listed for the Model CRT-2 CRT tester-reactivator, the Model CR-1 in-circuit capacitor tester, the Model SRT-1 in-circuit rectifier tester, the Models VT-10 and VT-1 vacuum-tube voltmeters, and the Model FC-2 tube tester.

A copy of this data sheet is available without charge from the manufacturer on request.

SNYDER PRODUCT BROCHURE

Snyder Manufacturing Company of Philadelphia has issued a new brochure covering its complete line of auto and TV antennas, TV and hi-fi tables, and auto accessories.

The catalogue is offered in an attractive black, blue, and gold folder into which the catalogue sheets can be placed or removed without folding or tearing. The entire folder fits into a file drawer.

Contact your local *Snyder* distributor or the company direct for a copy.

TUBE SURVEY

The Business and Defense Services Administration of the U. S. Department of Commerce, Washington 25, D. C. has just issued a nine-country survey entitled "Electron Tubes and Semiconductors: Selected European Countries" which shows that American producers are supplementing their U. S.-based marketing operations in some cases by establishing European outlets either through licensing agreements or by direct investment.

The survey was based primarily on information obtained from the U. S. Foreign Service. It covers Austria, Belgium, Denmark, France, Italy, Norway, Sweden, Switzerland, and the United Kingdom.

Copies of this first of a series of three publications being prepared in the Electronics Division are available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. at 25 cents each.

DALE BOOKLETS

Dale Products, Inc., Columbus, Nebraska has issued two new booklets, one on resistors and the other on trimmer pots.

The booklet "Trimmer Potentiometers" by Orlin Wately discusses the construction and desirable features of trimmers for solving miniaturization and environmental problems in circuit design. The second publication, entitled "Resistors," is written by Bernard Hay and covers the field of precision resistors. The booklet includes definitions of resistor terms, the construction and utilization of precision resistors, etc.

Each booklet is priced at 50 cents. Orders can be sent direct to the company or copies obtained from local sales representatives of the company.

WRL CATALOGUE SUPPLEMENT

World Radio Laboratories, 3415 W. Broadway, Council Bluffs, Ia. has announced the release of Supplement Catalogue No. 1 which is to be used with the company's 1960 catalogue No. 20.

The Supplement contains new items which were not included in the 1960 listing as well as carrying price changes and noting discontinued items. Copies are available on request.

"NOVICE LICENSE COURSE"

Electronic Instrument Co., Inc. is now offering a four-page brochure entitled "Short Course for the Novice License."

The booklet lists the Morse Code and contains general information regarding FCC requirements for becoming a ham operator. Many of the more common abbreviations in ham radio usage, popular "Q" signals, and radiotelephony call words are also included. An entire section is devoted to questions similar to those found on FCC examinations. Answers are given for these questions.

Copies of the booklet are available without charge from the company at 33-00 Northern Blvd., Long Island City 1, New York.

AUDIO CIRCUIT DATA

Amperex Electronic Corporation, 230 Duffy Ave., Hicksville, N. Y. has issued a 33-page booklet entitled "Audio Designers Handbook" which is being offered for $1.50 a copy.

The new publication contains comprehensive audio design information as well as an up-to-date collection of amplifier circuits for use by design engineers and advanced audiophiles. Information is included on a newly developed, high-gain, phase-splitter circuit and a low-voltage, high current output stage.

The handbook contains treatments of over-all requirements of mono and stereo systems, features of the ideal amplifier, amplifier performance criteria, the output stage, phase-splitter stage, voltage-amplifier stage, preamp stage, and power supply. A tabular listing of the firm's audio tubes is also included.

SEMICONDUCTOR HANDBOOK

The Industrial and Government Division of *Radio Shack Corp.*, 730 Commonwealth Ave., Boston 17, Mass. has announced publication of a semiconductor engineering guide which has been keyed to the need of both engineer and purchasing agent.

The book includes two listings of the semiconductors of nine manufacturers, in sequence by parameters and functions and by transistor and diode type number. The handbook also contains a section of dimensioned mounting diagrams. All of the more than 750 transistors and diodes listed are stocked by *Radio Shack*.

CHIMNEY MOUNTS

Channel Master Corp., Ellenville, N. Y. is offering copies of its comprehensive booklet on chimney mounts without charge upon direct written request.

The bulletin introduces three new heavy-duty mounts and, in addition, carries a complete specifications chart covering all units in the company's line. —30—

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ARC-3 RECEIVER—100-156 MC $24.95

VHF Crystal Control 8 channel, electric band change. 17 Tubes: 9001, 9002, 12A6, 12H6 12SH7, 12SL7, 2/12SN7, 3/12SG7, & 6/6AK5. Voltage required 210 VDC 125 MA and 24 VDC. Used $24.95

DATA RECORDER—16 MM CAMERA

Weather Observation Unit containing a sun angle optical system, 16 mm Magazine Camera that takes one exposure at a time and operates from 12 VDC, Mirrored Lens. Graph & Filter Assy., Barometer, Clock, Compass, and 12 VDC Digit Counter. Unit will record simultaneously on 16 mm film, one frame at a time, the lens exposure picture, and barometer, compass, time, & digit counter readings. With schematic for wiring control switches & power plug. Size: 15" L x 9" W x 17" H. Shpg. Wt.: 45 lbs. New: $16.95 Connector Plug: $2.00

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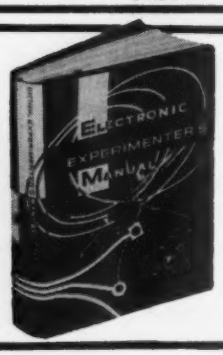

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ZW 560

Microwave Boom

(*Continued from page* 44)

the reflector, the problems sometimes caused by transmission lines can be avoided.

By using passive reflectors, it is often possible to provide a communications path between two microwave stations at far lower cost than if the antennas are directly fed. At a power generating plant, deep in a canyon in the Cascades, the microwave signal is beamed at a passive reflector on a mountainside which reflects the signal to a distant passive reflector, which in turn reflects the signal down into another canyon. The *Southern Pacific* railroad didn't attempt to install a "live" repeater on Mt. Shasta. Instead, a passive reflector on the side of the "queen of the Cascades" reflects a microwave signal from Dunsmuir to Black Butte.

In the 960 and 2000-mc. bands, coaxial cable can be used for feeding antennas, but at 6000 mc., waveguide or passive reflectors must be used. Passive reflectors, however, are also used in systems operating in the 960 and 2000-mc. bands.

Servicing Opportunities

As the use of microwave expands, there will be an increasing demand for technicians to service the equipment. Most railroads employ full-time maintainers but many other users who are not staffed by competent technicians will look outside for maintenance assistance.

To service microwave equipment, a first or second class commercial radio operator's license is required. While it doesn't affect operator licensing, it is curious to note that microwave transmission of voice is considered radiotelephony and transmission of TV is considered as radiotelegraphy.

There are already thousands of microwave repeater and terminal stations in use. Under the new FCC policy, their number will increase rapidly. Because of the directivity of the antenna systems, saturation of the available bands will not occur nearly as rapidly as in mobile radio. While it has been reported that access into New York City *via* a 2000-mc. microwave channel is almost impossible because of the number of systems feeding into Manhattan, there is still plenty of room in other bands and through the use of appropriate antenna systems.

With the exception of scatter systems, which do not use space economically, the number of microwave systems that can be operated on currently available frequencies is fabulous. Looking at a microwave signal as a light beam emitted from a searchlight, and even forgetting difference in frequency, the number of possible microwave systems is virtually limitless. Therefore, it would seem that microwave activity is shaking off some lethargy and starting to boom. —30—

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___	1AX2	.62	___	3CS6	.52	___	5EU8	.80	___	6BC7	.94	___	6CU6	1.08	___	7B6	.69	___	12AV5	.97	___	12DM7	.67	___	17W6	.70
___	1B3GT	.79	___	3CY5	.71	___	5J6	.68	___	6BC8	.97	___	6CY5	.70	___	7Y4	.69	___	12AV6	.41	___	12DQ6	1.04	___	19AU4	.83
___	1DN5	.55	___	3DE6	.62	___	5T8	.81	___	6BD6	.51	___	6CY7	.71	___	8AU8	.83	___	12AV7	.75	___	12DS7	.79	___	19BG6	1.39
___	1G3	.73	___	3DK6	.60	___	5U4	.60	___	6BE6	.55	___	6DA4	.68	___	8AW8	.93	___	12AX4	.67	___	12DZ6	.56	___	19T8	.80
___	1J3	.73	___	3DT6	.50	___	5U8	.81	___	6BF6	.44	___	6DB5	.69	___	8BQ5	.60	___	12AX7	.63	___	12EL6	.50	___	21EX6	1.49
___	1K3	.73	___	3Q5	.80	___	5V6	.56	___	6BG6	1.66	___	6DE6	.58	___	8CG7	.62	___	12AZ7	.86	___	12EG6	.54	___	25AU4	.87
___	1L6	1.05	___	3S4	.61	___	5X8	.78	___	6BH6	.65	___	6DG6	.59	___	8CM7	.68	___	12B4	.63	___	12EK6	.56	___	25BQ6	1.11
___	1LA6	.69	___	3V4	.58	___	5Y3	.46	___	6BH8	.87	___	6DQ6	1.10	___	8CN7	.97	___	12BA6	.50	___	12EZ6	.53	___	25C5	.53
___	1LC6	.79	___	4AU6	.54	___	6AB4	.46	___	6BJ6	.62	___	6DT5	.76	___	8CX8	.93	___	12BD6	.50	___	12F5	.66	___	25CA5	.59
___	1LN5	.59	___	4BA6	.51	___	6AC7	.96	___	6BK5	.80	___	6DT6	.53	___	8EB8	.94	___	12BE6	.53	___	12F8	.66	___	25CD6	1.44
___	1R5	.62	___	4BC5	.56	___	6AF3	.73	___	6BK7	.85	___	6EU8	.79	___	10DA7	.71	___	12BF6	.44	___	12FM6	.45	___	25CU6	1.11
___	1S5	.51	___	4BC8	.96	___	6AF4	.97	___	6BL7	1.00	___	6EA8	.79	___	11CY7	.75	___	12BH7	.73	___	12K5	.65	___	25DN6	1.42
___	1T4	.58	___	4BE6	.54	___	6AG5	.65	___	6BN4	.57	___	6EB8	.94	___	12A4	.60	___	12BK5	.70	___	12SA7M	.86	___	25EH5	.55
___	1U4	.57	___	4BN6	.75	___	6AH6	.99	___	6BN6	.74	___	6H6GT	.58	___	12AB5	.55	___	12BL6	.56	___	12SK7GT	.74	___	25L6	.57
___	1U5	.50	___	4BQ7	.96	___	6AK5	.95	___	6BQ5	.65	___	6J5GT	.51	___	12AC6	.49	___	12BQ6	1.06	___	12SN7	.67	___	25W4	.68
___	1X2B	.82	___	4BS8	.98	___	6AL5	.47	___	6BQ6GT	1.05	___	6J6	.67	___	12AD6	.57	___	12BY7	.74	___	12SQ7M	.73	___	25Z6	.66
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___	2BN4	.60	___	4BZ6	.58	___	6AN4	.95	___	6BR8	.78	___	6S4	.48	___	12AF3	.73	___	12C5	.56	___	12V6GT	.53	___	35L6	.57
___	2CY5	.71	___	4BZ7	.96	___	6AN8	.85	___	6BS8	.90	___	6SA7GT	.76	___	12AF6	.49	___	12CA5	.59	___	12W6	.69	___	35W4	.52
___	3AL5	.42	___	4CB6	.59	___	6AQ5	.50	___	6BU8	.70	___	6SK7GT	.74	___	12AJ6	.46	___	12CN5	.56	___	12X4	.38	___	35Z5GT	.60
___	3AU6	.51	___	4CS6	.61	___	6AR5	.55	___	6BY6	.54	___	6SL7	.80	___	12AL5	.45	___	12CR6	.54	___	17AX4	.67	___	50B5	.60
___	3AV6	.41	___	4DE6	.62	___	6AS5	.60	___	6BZ6	.54	___	6SN7	.65	___	12AL8	.95	___	12CU5	.58	___	17BQ6	1.09	___	50C5	.53
___	3BA6	.51	___	4DK6	.60	___	6AT6	.43	___	6BZ7	.97	___	6SQ7	.73	___	12AQ5	.52	___	12CU6	1.06	___	17C5	.58	___	50DC4	.37
___	3BC5	.54	___	4DT6	.55	___	6AT8	.79	___	6C4	.43	___	6T4	.99	___	12AT6	.43	___	12CX6	.54	___	17CA5	.62	___	50EH5	.55
___	3BE6	.52	___	5AM8	.79	___	6AU4	.82	___	6CB6	.54	___	6T8	.80	___	12AT7	.76	___	12DB5	.69	___	17D4	.69	___	50L6	.61
___	3BN4	.63	___	5AN8	.86	___	6AU6	.50	___	6CD6	1.42	___	6U8	.78	___	12AU6	.50	___	12DE8	.75	___	17DQ6	1.06	___	117Z3	.81
___	3BN6	.76	___	5AQ5	.52	___	6AU7	.61	___	6CF6	.64	___	6V6GT	.54												
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___	3CB6	.54	___	5BR8	.79	___	6AX4	.65	___	6CN7	.65	___	6X5GT	.53												
			___	5CG8	.76	___	6AX7	.64	___	6CR6	.51	___	6X8	.77												
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Inexpensive Modulator Transformers

By R. P. HAVILAND, K3BGX

Some tips on using surplus power transformers as modulation transformers in ham transmitters.

AT THE higher power levels, the cost of modulator transformers becomes an appreciable part of the total cost of a transmitter. This makes an inexpensive modulation method very attractive. One way of securing satisfactory modulation at very low cost is to use high-level class B modulators with power transformers used as the modulator transformer. Since power transformers are readily available in surplus stocks, satisfactory units can be found for practically nothing.

When considering a power transformer for modulation, it is necessary to examine four different specifications. These are: the voltage rating of the windings, the impedance transformation available, the breakdown voltage of the insulation, and the current rating.

Most power transformers of the surplus type are rated for either 60-cycle or 50/60-cycle operation. In audio or

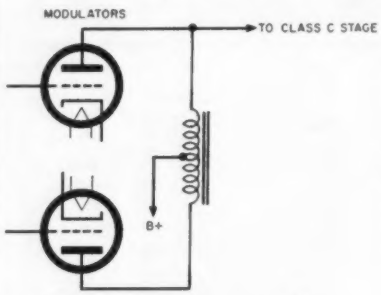


Fig. 1. Autotransformer connection.

modulation service the voltage rating of the windings is increased since the allowable voltage across the winding increases linearly as the lowest frequency present increases. Further, in modulation transformers, the most important rating is the peak voltage which is 40% greater than the r.m.s. voltage used in power ratings.

For example, assume that a transformer is available which is rated at 440-0-440 volts at 50/60 cycles. For amateur audio work 200 cycles may be assumed to be the lowest frequency present in the audio, since only voice is to be transmitted. In this case, the rating of the transformer for audio work is equal to 440 × 200/50 or 1760-0-1760 r.m.s. volts. The peak rating is 1760 × $\sqrt{2}$ or 2500-0-2500 peak volts.

Since the total audio voltage swing per tube in a class B stage cannot exceed the d.c. supply voltage, this transformer is suitable for use in a class B stage operating with 2500 volts (or less) on the plate. Thus, it would be suitable for use with 811's operating at 1500 volts or even with 813's operating at 2500 volts.

The possible impedance transformation is a function of the windings available on the transformer. For the autotransformer connection shown in Fig. 1 there is a 2 to 1 voltage stepdown from the plate of the class B stage to the class C load. Since the impedance ratio varies with the square of the voltage, this is a 4 to 1 impedance transformation. This is often satisfactory: for example, this connection would give a 16,000-ohm plate-to-plate impedance for a 4000-ohm class C load.

The disadvantage of this connection is that the modulated stage must operate at the same voltage as the class B stage. In many cases, such as modulation on a pair of 812's by a pair of 811's, this is perfectly satisfactory. For other cases, it may be necessary to use the modified Heising system shown in Fig. 2. The size of the capacitor should be chosen to have about 1/10 the reactance of the modulated stage impedance at the lowest audio frequency. The choke reactance at the lowest audio frequency should be several times as large as the modulated stage impedance.

Where a 4 to 1 impedance transformation is not satisfactory, the remaining winding or windings of the power transformer may be used to secure other impedance levels by connecting these as shown in Fig. 3. The polarity of the added winding or windings may

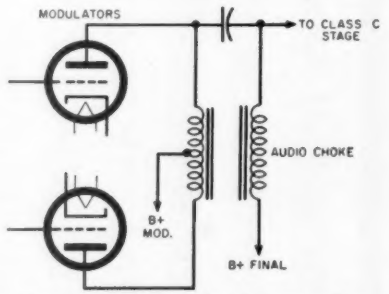
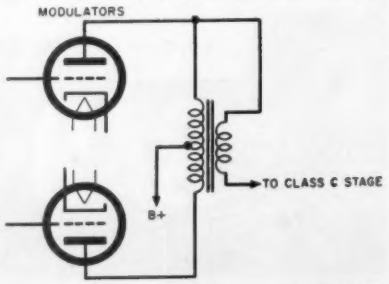


Fig. 2. A modified Heising connection.

Fig. 3. Extended autotransformer hookup.



be chosen to give more or less than the 4 to 1 ratio. The impedance ratio actually obtained is easily calculated by determining the voltage rating of the windings from plate-to-plate and from center-tap to the class C terminal. The ratio of this, squared, is the impedance ratio.

In addition to this technique, it is also possible to use two transformers connected back-to-back. This is the same as the usual link coupling in r.f. circuits. The over-all transformation ratio is calculated as before by determining the voltage ratio and squaring. This connection allows the use of different voltages for the class B and class C stages and also makes possible physical separation of the class B and class C stages.

The current rating is the easiest to check. For any winding this should be at least equal to 1½ times the total d.c. current flowing through the winding. This allows for the audio component of current. For example, in a transmitter using the autotransformer connection of Fig. 1 to connect push-pull 811's to push-pull 812's, the largest total current is the current to the 812's plus one half of the peak current to the 811's. Typically this would be 250 ma. + 300/2 ma. or 400 ma. The transformer rating should be at least 0.6 amp.

In addition to the voltage and impedance, the quality of the insulation must be checked. In many cases this can be determined from the nameplate on the transformer since surplus units usually give a test voltage. For the amateur service, operation at this test voltage is quite satisfactory as far as life is concerned since the total number of hours of operation with voltage applied is small even over a 5-year period. However, if operation is required at voltages above the test voltage, for safety the case of the transformer should either be thoroughly grounded or an insulated enclosure provided. In this latter case, it is acceptable to connect the case and core of the transformer to the "B+," which reduces the load on the insulation.

An additional way to check the voltage rating is to apply approximately twice the plate voltage between the windings and the transformer cover for a period of about 5 minutes. This is easily done in most amateur transmitters by temporarily shorting out the filter choke of the power supply. This will give about 1.8 times the required power-supply voltage. Caution: Be sure to disconnect the class C stage and check the voltage rating of the filter capacitor before doing this.

When a transformer is operated above its insulation rating, it must be understood that there is a chance that it will fail. Because of this possibility, extra precautions as to personal safety are required. Also, fuses should be used to protect other components.

A modulation transformer has a greater chance of survival if it is given protection against loss of the class C stage load. This protection is easily provided by connecting a needle gap across plate connections of the transformer. The needles should be set so that their spacing, in inches, is equal to the plate voltage divided by 6700. This gives a breakdown voltage of 1½ times the plate supply voltage.

K3BGX has been using this modulation system for 12 years. The transmitter uses push-pull 812's modulated by push-pull 811's. The transformer used is a war surplus Navy sonar transformer which was rated at 220/440 volts, to 136 volts center-tapped, and is rated at 3000 volts test. Power rating is 1.5 amperes in the primary, at 60 cycles. The transformer is used with the 220/440-volt winding for the plate-to-plate connection with one half of the 136-volt secondary connected to one plate to give an impedance ratio slightly greater or slightly less than 4 to 1. The power rating of the transformer is adequate for parallel push-pull 811's although these are not used. —30—

TRI CITY HAMFEST

THE Tri City Amateur Radio Council will hold its annual hamfest on Saturday, May 14th, at Ocean Beach Park in New London, Conn.

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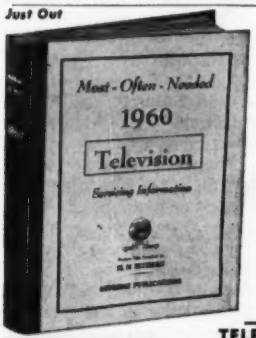

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Should You Move?

(Continued from page 65)

growth, so as to provide a continuing influx of new customers? Don't be taken in by big booms created by a passing situation.

18. Will costs of living be in line with those you now have, or even lower? If they are higher, there is always the danger that, even with improved gross business, you will be right back where you started or even worse off.

19. Is the new area being serviced by outside shops? If it is, a man who is on the spot generally has a good chance of winning out over such competition.

20. Are prices fairly stable in the new area? Check back over as long a period as possible. If the area is subject to more ups and downs than most others, what looks like a good opportunity now, while things are on the upswing, may turn into something less desirable than the one you now have.

21. Is the decision to move being based on your own personal investigation of the facts? If you have been taking the words of other people for the golden future that lies ahead, either make your own check quickly or put down a check in the "No" column.

22. Will you be able to make use of most of your present equipment? If the move is going to involve a considerable investment in new equipment, this is another burden you will have to carry out of income.

23. Will your competitive position be similar to the one in which you are now operating? It isn't easy to anticipate how you will have to deal with unfamiliar situations. For example, if you are going to have to buck a "big operator" or a "wholesale-retail" competitor for the first time, you may find yourself with more on your hands than you can handle.

24. Are financial interests in the area friendly with service businesses of various kinds and have they already demonstrated a willingness to assist them and an understanding of their special problems? Financial men, particularly with lending institutions, who know something about your problems are always an asset. In many areas, there is a reluctance on the part of lenders and bankers to cooperate with businesses that sell services rather than goods.

25. Aside from other initial expenses, do you have financial resources sufficient to carry you for a period of a few months? At the beginning, this may involve enough for living costs until you have built up adequate trade and also money with which to do business until you have established credit.

26. Are there personal reasons that make the move desirable or necessary? The health of a member of your family, for example, may make the move from one climate to another advisable. Such a reason may be as hard a fact and carry as much weight as any purely financial factor. —30—

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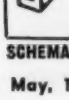

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200-1500 Kc
2 to 18.1 Mc

$48.50

Complete with Tubes
Famous Collins Autotune Aircraft Transmitter, AM, CW, MCW. Quick change to any of ten preset channels or manual tuning. Speech amplifier/clipper uses carbon or magnetic mike. Highly stable, highly accurate VFO. Built in Xtal controlled calibrator. PP811's modulate 813 in final up to 90%, class "B." A Real "HOT" Ham buy at our low price!
Orig. cost $1800. Exc. Used **$48.50**
0-16 Low Freq. Osc. Coil for ART-13 ..... 7.95
24V Dynamotor for ART-13 ..... 11.95
Same as above less meter 39.50

APR-5A UHF RECEIVER

The APR-5A is a superhet receiver with 2 frequency ranges: (1) from 1000 to 3100 megacycles. (2) from 3000 to 6000 megacycles continuous by means of interchangeable mixers using a single dial tuning control. It has a 10 mcs. I.F. band width of 30 megacycles center. Operates from 80-115 V. 1 phase, 60-2600 cycles. Variable I.F. gain by use of a pot. Use for frequencies above 1000 megacycles to supplement range of APR-4 receivers. Like New, with all tubes **$59.50**

FAMOUS BC-645 TRANSCEIVER
15 Tubes 435 To 500 MC

BRAND NEW

Can be modified for 2-way communication, voice or code, on ham band 420-450 mc, citizens radio 460-470 mc, fixed and mobile 450-460 mc, television experimental 470-500 mc. 15 tubes (alone worth more than sale price!): 4—7F7, 4—7H7, 2—7E6, 2—6F6, 2—955 and 1—WE-316A. Now covers 460 to 490 mc. Brand new BC-645 with tubes, less power supply in factory carton.
Shipping weight 25 lbs. **$29.50**
PE-101C Dynamotor, 12/24V input $7.95
UHF Antenna Assembly 2.45
Complete Set of 10 Plugs 5.50
Control Box 2.25

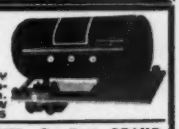
SPECIAL "PACKAGE" OFFER:
BC-645 Transceiver, Dynamotor and all accessories above. COMPLETE, BRAND NEW, While Stocks Last **$42.00**

TG-34A CODE KEYER

Self-contained automatic unit, reproduces code practice signals recorded on paper tape. By use of built-in speaker, provides code-practice signals to one or more persons at speeds from 5 to 25 WPM.
BRAND NEW $22.50
Checked out, exc. used **$18.95**

MOBILE-MARINE DYNAMOTOR

Model DM35



Input 12V DC, Output: 625 V DC @ 225 Ma. for press-to-talk intermittent operation. Shpg. wt. 14 lbs. **OUR LOW PRICE, BRAND NEW... $8.45**

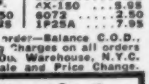
OTHER DYNAMOTOR VALUES:	Input	Output	Excellent Used	BRAND NEW
DM-25	12V 2.2A	250V .050A		$4.50
DA-1A	28V 1.6A	230V .100A		3.95
DM-28	28V	224V .07A	2.75	4.75
DM-32A	28V 1.1A	250V .05A	2.45	4.45
DM-33A	28V 5A	575V .16A		
	28V 7A	540V .25A	1.95	3.75
DM-34D	12V 2A	220V .080A	4.15	5.50
DM-53A	28V 1.4A	220V .080A	3.75	5.45
DM-64A	12V 5.1A	275V .150A		7.95
PE-73C	28V 20A	1000V .350A	7.95	10.50
PE-86	28V 1.25A	250V .050A	2.75	3.85

MOBILE 9-VOLT DYNAMOTOR SPECIAL

INPUT: 9 Volts DC @ 7.5 Amps.
OUTPUT: 400 Volts DC @ .095 Amps.
May be used for 6 volt operation. BRAND NEW in original carton **$3.95**
80-77 DYNAMOTOR Input 14V @ 30A. Output 1000V @ .350 A with starting solenoid, Filter Box and Mounting Base ..... Like New **$14.95**

SMALL DC MOTORS

All 27V DC Input.
Overall 3¾" x 1¼" Dia.



5069600 Delco PM 250 rpm.. $4.45
5069700 Delco PM 100 rpm.. $4.95
5069800 Delco PM 575 rpm, reversible governor controlled with 27V DC Clutch $4.95
SBA10AJ32 145 rpm, reversible $4.45

STANDARD TUBES
Removed from Brand New Gov't Equipment

RECEIVING					
6AG5	.35	6J5	.65	813	6.95
12AT7	.45	6N6	.55	814	2.25
6AK5	.85	6SL7	.85	815	2.15
6C4	.25	12AE	.45	826	.44
6AL5	.38	SPECIAL PURP.		1629	.29
6AC7	.55			5X-150	2.95
6J6	.32	2C39	3.50	6072	2.50
6V6	.65	3E29	4.25	1P25A	7.95

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G & G Radio Supply Co.
Telephone: CO 7-4605
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20 TO 27.9 MC.

Excellent Used $14.95
BRAND NEW $16.95
Convert to 30-50 Mc., and A.M.! (See CQ Sept. '58 and Dec. '59.) 10 Channel, pushbutton tuning or continuous tuning. Complete with speaker, tubes, squelch.

12 or 24V Dynamotor for Above. Exc. Used $4.25 ..... Brand New **$5.50**
BC-604 TRANSMITTER—Companion unit for BC-603 Rcvr above. With all tubes. BRAND NEW.... $10.95
With Tubes, Used $4.95
BC-683 same as above except 27 to 38.9 Mc. Brand New **$27.50**

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Complete 240-page Technical Manual for BC-603, 604 ..... **$2.95**

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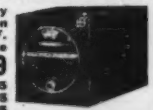
6-channel xtal control. Freq. 108.3 to 110.3 Mc. Dual filter range. Easily converted for tracking Sputniks!
$8.95
Brand New complete with tubes .....
Dynamotor for above 24 V. New $3.95

BC1206-C BEACON RECEIVER



195 to 420 Kc. made by Setchel - Carlson. Works on 24-28 volts DC. 135 Kc. IF. Complete with 8 tubes. Size 4" x 4" x 6". Wt. 4 lbs. BRAND NEW... $9.99
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2-meter Superhet. 100 to 156 Mc in 4 crystal channels. Complete with 10 Tubes. **BRAND NEW $24.45**
110V AC Power Sup. Kit for above **$9.75**

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100-150 Mc Includes 2—832A, 2—1625 Tubes. BRAND NEW **$21.50**
SPECIAL OFFER! Limited quantity **ARC-5/T23 xmitters.** Excellent Used, less tubes..... $5.95
MD-7 MODULATOR for T-23, complete with 4 tubes. LIKE NEW..... **$9.95**

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SCR-274 COMMAND EQUIPMENT
ALL COMPLETE WITH TUBES

Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC	$12.95	$14.95
BC-454	Receiver 3-6 Mc	9.45	12.45
BC-450	3-Receiver Control Box	1.39	1.75

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234-258 MC RECEIVER
AN/ARR-2

BRAND NEW 11-tube UHF Tunable Receiver with schematic. Only a few at this low price! Complete with tubes **$8.88**

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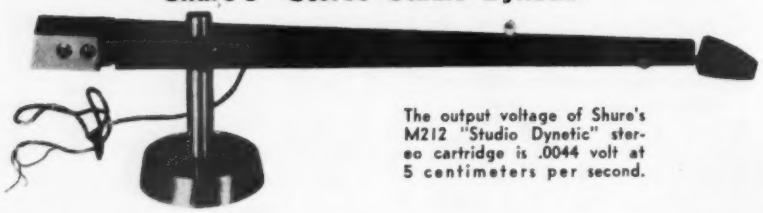
ELECTRONICS LAB TESTED WORLD

Product Report

Shure's "Stereo Studio Dynetic"



The output voltage of Shure's M212 "Studio Dynetic" stereo cartridge is .0044 volt at 5 centimeters per second.

IN view of the rather limited production and unusual demand, it is only within the last month that we were able to get a model of *Shure's* new integrated tone arm and cartridge assembly. The arm itself seems to be identical to the monophonic version announced approximately three years ago. Both in performance and appearance, this new assembly is one of the finest on the market today. The Model M212 is the one we checked and it is designed for playing records up to 12 inches in diameter. *Shure* also has a longer version, Model M216, for use with records up to 16 inches in diameter. The arm is a tapering, slender black aluminum assembly holding a tiny cartridge which is capable of tracking records at a stylus pressure of 1.5 to 2.5 grams.

It is unusual in that the arm cannot be moved in a vertical direction; that is, the arm is not lifted when placing the stylus on the record. Instead, the lift button, protruding from the top of the arm approximately ⅛ of the distance from the tip as shown in the photograph, is pressed. This lifts the cartridge and when the arm is moved over the record, releasing the button lowers the cartridge into place. Our first attempts in using this turned out to be rather awkward. It certainly is not customary to press down when placing the tone arm into playing position, but after several tries, we became quite adept in its use.

Another important feature is that the entire pivot action (using jeweled bearings) and adjustable counterweight are near the tip of the tone arm. The pivot point can be seen in the photograph directly behind the cartridge and the counterweight is within the arm's shell and is equally spaced just to the rear of this point.

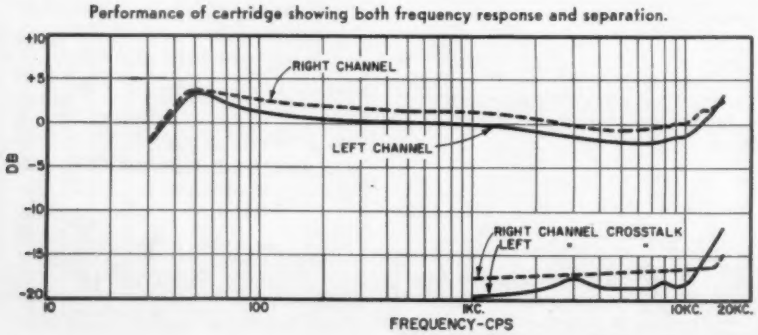
Similar to *Shure's* very popular stereo cartridges, the M3D and M7D, the pickup used in the M212 is a moving-magnet type which is to be used with a 47,000-ohm load. The stylus tip radius is .7 mil and the manufacturer claims lateral and vertical compliances of 9 x 10^{-6} cm./dyne and a needle tip mass of 1.3 mg.

In checking its performance, we used a *Westrex* 1A test record and a stylus pressure just slightly under 2 grams. Its performance can be seen in the accompanying graph. It is interesting to note the uniformity obtained in the response between the two channels and particularly the channel separation results. Actually the channel separation is among the best that we have encountered to date. The measurements, as shown in the graph, are not quite fair to the manufacturer. Although we use a *Hewlett-Packard* v.t.v.m., the opposite-channel voltage is so low it is rather difficult to take accurate measurements. We had a residual hum of .00036 volt inherent in the hi-fi system that affected our channel separation readings. We feel sure that more accurate channel-separation figures for this new cartridge would exceed 20 db across the range of 30 to 15,000 cps, the limits of our test.

We were particularly pleased with the remarkable freedom from record hiss, the non-existence of needle talk, and the freedom from hum pickup. With a stylus pressure of less than 2 grams, we encountered no tracking problems even when playing extremely loud passages, both monophonically and stereophonically. The entire Model M212 assembly, including arm and cartridge and a replaceable diamond stylus, is available at a net price of $87.71.

—30—

Performance of cartridge showing both frequency response and separation.



Johnson's Citizens Band Transceiver

THE name *Johnson* "Viking," known on the ham bands for amateur gear, has recently been applied to a compact, conservatively designed Citizens Band transceiver, the "Viking Messenger." This unit is a 5-channel, 10-tube set with a crystal-controlled superhet receiver and a 5-watt transmitter.

We have just had a chance to try out a pair of these units, and we can report that the transceiver does its job well. We had a little difficulty in trying to load one particular ground-plane antenna (incidentally not made by *Johnson*); we got no indication of output on the unit's output indicator lamp. But when we tried two other antennas, a quarter-wave whip and a base-loaded whip, the indicator lighted normally and the transmitter operated properly. The output indicator is simply a neon lamp wired across the screen-dropping resistor of the transmitter's power-amplifier tube. With normally loaded screen current this lamp should light and, since the plate and screen of the amplifier are modulated, it should flicker along with the modulation.

A modified pi-network antenna coupling circuit is used so that it should be possible to load almost anything from a random length of wire to a beam antenna. As a matter of fact, access holes in the bottom of the case permit adjustments to be made of both plate tuning and antenna coupling. But we felt that most users would attempt to operate the unit "as is," so no output tuning adjustments were made. The adjustments, by the way, must not be made indiscriminately without metering the final amplifier's plate current, otherwise the 5-watt power input limit set by the FCC might be exceeded and the amplifier tube might be overloaded.

On-the-air operation of the transceiver showed good receiver sensitivity

and an effective, positive-acting squelch circuit. Reports on the transmitter signals show them to be clean and well-modulated. We operated the unit on two widely separated channels (5 and 18), and noted a slight change in output-indicator brightness (actually screen current) in switching from one to the other. This is normal and to be expected since the unit was probably pre-adjusted for a single, compromise setting.

A check of the circuit shows that the receiver is a conventional single-conversion superhet with an r.f. amplifier, crystal-controlled pentagrid mixer, and a single i.f. stage operating at 455 kc. A diode noise limiter is included along with an adjustable squelch circuit operating in conjunction with the receiver's audio amplifier. The voltage amplifiers and 12AB5 output stage do double-duty as mike amplifiers and modulator when the unit is switched to transmit.

The transmitter section employs a 7054 crystal oscillator coupled to a 7061 final power amplifier operating with the maximum legal power input of 5 watts. A push-button on the ceramic microphone operates the built-in antenna changeover relay for push-to-talk operation. The receiver is disabled, by disconnecting the built-in speaker, during transmission times.

The transceiver operates either from the 117-volt a.c. power line or from a 12-volt battery. The power supply uses a 12BW4 in a conventional full-wave circuit. A vibrator in the unit feeds the same power transformer and rectifier when operating from a battery. In order to operate on a battery, it is only necessary to change the power cord. Other models of the transceiver are available for 117-volt a.c. and 6-volt d.c. operation, or for a.c.-only operation.

The front panel of the unit measures only 5⅝" high by 7" wide, while the depth of the transceiver just over 11". This means that it will take a minimum amount of dashboard space when mounted in an automobile, truck, or in a boat. As a matter of fact, the manufacturer has available as an accessory unit a universal dash-mounting kit for this very purpose. In addition, if ignition noise is so severe that the set's noise limiter cannot cope with it, another accessory kit is available from the manufacturer that should effectively suppress this noise.

The instruction manual contains two almost-full-size photos showing top-chassis and bottom-chassis views with all components and adjustments clearly identified. These along with the schematic of the transceiver, showing all voltages and resistances both in the transmit and receive modes, will be of considerable help in servicing and troubleshooting the gear.

The "Viking Messenger" sells for $139.75, complete with microphone, power cords, and crystals for one channel. In addition to being available from *Johnson* distributors, the transceiver is also being handled by *General Electric* distributors. -30-

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☐ 60 Condenser Spec. Molded, mica, ceramic, oil, paper, discs. $15 val. $1

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LEKTRON 133 Everett Ave. CHELSEA 50, MASS.

Compact Amplifier

(*Continued from page 61*)

in the a.f. input circuit is not reduced by feedback, because this circuit is outside the feedback loop.

2. Ground the "B-minus" bus to the chassis only at the a.f. input terminal. If a plug-and-socket arrangement is used for the speaker connection, be sure the ground side of the voice-coil circuit is connected only to the "B-minus" bus and not to the chassis of the amplifier.

3. Connect all ground returns to the "B-minus" bus in the order shown on the schematic. Remember, the high ripple current in the plate supply for the output stage can raise the amplifier's hum level if it enters either of the preceding stages through the common "B-minus" bus. Although this type of hum originates within the amplifier's feedback loop, it often becomes so great that it cannot be eliminated by feedback.

Performance Data

Fig. 6B shows the frequency response curve of the amplifier while Fig. 6A shows its total harmonic and intermodulation distortion as functions of power output. Note that at normal home-listening levels both IM and harmonic distortion are substantially below the one-half of one per-cent level. Despite the relatively large amount of inverse feedback used the amplifier has a sensitivity of .42 volt r.m.s. for 20 watts output. Hum and noise, with input shorted, are 84 db below 20 watts.

Fig. 5 shows the square-wave response of the amplifier at 100, 1000, and 10,000 cps. The slight overshoot in the 10,000-cps square-wave response is due to the peak in the 20-watt frequency-response characteristic at 48,000 cps (see Fig. 6B).

As a check on the performance of the input-amplifier and phase-splitter stages, the combined cathode currents of these stages were measured over a wide range of signal levels. No change in current occurred until the output of the phase splitter reached a level of 170 volts peak-to-peak, indicating that there is no departure from class A operation up to signal levels three times greater than that required to drive the 6973's to full output.

Because a major factor in the performance of an audio power amplifier is the output transformer, considerable care was exercised in selecting a compact transformer which would provide the desired performance yet be moderate in cost. Several small output transformers having suitable power ratings were tried, but these lacked the necessary response and power-output capabilities at extreme high and low frequencies. Although the transformer used is not the most expensive small unit available, it proved to be an excellent choice for this compact economy amplifier.

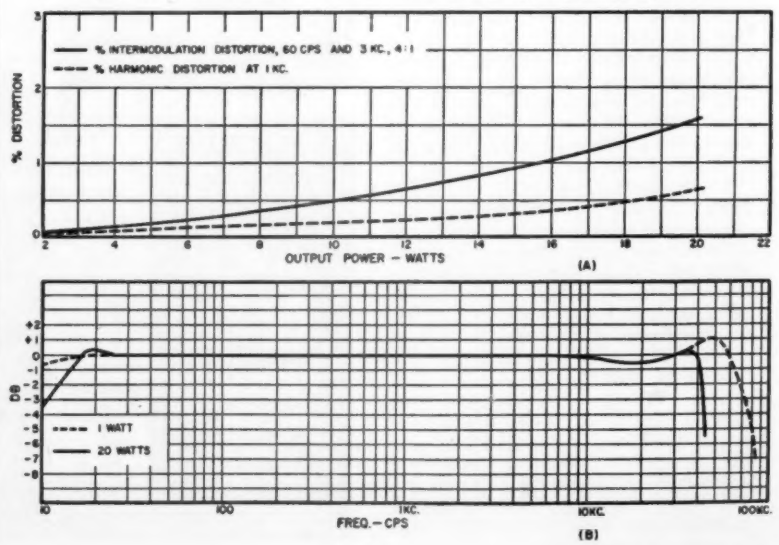
Power Output	20 watts
Sensitivity	0.42 volt input for 20 watts
Hum & Noise	84 db below 20 watts
Distortion	Total harmonic: @ 1 kc., 20 w. = 0.6%; IM @ 60 cps & 3 kc. (4:1) @ 20 w. = 1.55%
Damping Factor	10 @ 60 cps, 8-ohm tap

Table I. Important specifications of unit.

Although the output transformer is rated at 15 watts, it performs well at the 20-watt level. Because one rarely operates an amplifier continuously in the home at more than a few watts output, there should be little danger that the manufacturer's ratings will be exceeded.

Observe the precautions listed when you build this amplifier and you will have a unit that provides many enjoyable hours of monophonic or stereo listening. —30—

Fig. 6. (A) Intermodulation and harmonic distortion. (B) Frequency response.



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A Low-Cost Visitor Annunciator

By JIM MARTIN

By eliminating the customary relay, this signalling circuit can be built easily and at small expense.

THE outstanding feature of this annunciator is its comparatively low cost. Unlike most electric-eye systems, this circuit doesn't employ a relay—a factor which contributes to the low cost. The other factor is the use of the NE-77 neon lamp. Although the operation of this tiny three-electrode neon lamp is similar to that of a cold-cathode thyratron—its cost is considerably lower, averaging about 50 cents at retail.

Since this circuit is very economical to construct, it will find numerous applications where a person would not bother to use a more expensive electric-eye system. These applications are to be found both in the home and in the shop. For example, it can be used to indicate when a customer has entered the shop. Those who might hesitate to install a more expensive annunciator system for this purpose would jump at the idea of installing a simple, low-cost unit of this type.

A 7½-watt night light serves as the light source to operate the unit. Dependable operation is possible up to distances of 8 feet. This distance is more than enough for practically all annunciator applications. If, however, greater distance is desired and no change in the light source is contemplated, sensitivity of the circuit may be increased by substituting a slightly lower value for R_1. The exact value should be determined by experiment.

Elimination of the relay was accomplished by taking advantage of the buzzing sound emitted by a speaker when pulsating direct current activates it. This pulsating d.c. is obtained from the a.c. line after being rectified and controlled by the NE-77 neon lamp. Current is allowed to flow whenever the lamp is triggered—which occurs when someone breaks the beam of light that activates the photocell. This causes the resistance of the cell to increase in value which, in turn, allows the voltage between R_1 and PC_1 to reach the value required to trigger the lamp.

As can be seen from the diagram, when the unit is on there will be current passing through the output transformer irrespective of whether or not the light source is blocked. However, there will be no noticeable sound from the speaker since, after passing through the high-resistance voltage divider, this current is extremely small.

In this circuit the speaker serves the same purpose as the buzzer does in a relay-type system. The cost of the speaker and its output transformer just about equals that of the buzzer with its accompanying line-voltage-stepdown transformer.

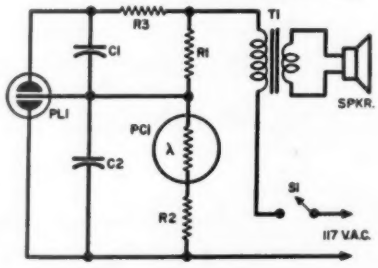
It is just possible that the volume will be greater than that required, in which case it may be lowered by increasing the value of R_3. Incidentally, this will also increase the life of the NE-77.

A three-inch-long cardboard tube is placed over the photocell to prevent extraneous light from actuating the annunciator. This length was tested under conditions where the distance between the light and the unit did not exceed the 8-foot maximum. For greater distances this length may have to be increased to keep the stray light from upsetting the more sensitive circuit. The tube diameter should be a tight fit over the photocell.

If the unit or the speaker is housed in a metal box, the standard precautions for avoiding shock should be taken by isolating the circuit from the box.

This circuit is entirely suitable for use in the home as well as the shop since the use of a single two-conductor cable from the unit makes the installation inconspicuous enough for domestic applications. —30—

Circuit of annunciator. A 7½-watt night light serves as the light source. Unit will operate at distances up to 8 feet.



R_1—2.2 megohm, ½ w. res.
R_2—1 megohm, ½ w. res.
R_3—15,000 ohm, ½ w. res.
C_1, C_2—50 μμf. ceramic capacitor
T_1—Output trans., 8000 ohm pri. (Stancor A-3329 or equiv.)
PC_1—Photocell (Clairex CL-3 or equiv.)
PL_1—NE-77 neon lamp
S_1—S.p.s.t. switch
Spkr.—4" speaker, 3.2-ohm voice coil

Low-Ripple Adapter

(*Continued from page 57*)

copper side up, the conductor pattern shown in Fig. 6 is traced on it. The tape is then cut into suitable strips of such size and shape that they can be laid down to cover the pattern faithfully. The board is then etched in the ferric chloride solution until the undesired copper is completely removed, and the board is cleaned. Next drill the holes in the pattern where indicated (Fig. 6) and solder the transistor socket and other components in place on the reverse side (Fig. 5).

After all solder connections have been made on the board, spray the conductor side with clear *Krylon* or a similar plastic spray. In the author's adapter, the printed board was mounted on the heat sink with ¼-inch brass standoffs (Fig. 3). The wires going to S_1 were cabled together and run through a hole in the back of the case. The low-ripple output leads follow the same route, and connect to two new output posts on the front of the battery eliminator's case. S_1 and the fuse for the low-ripple output line are also mounted on the front of the case but these parts can be mounted wherever space is available on your supply if it is not the same type as that shown. See Fig. 4.

Operation

Leads can be connected to both the original and the new output posts, or to only one pair at a time, whichever is desired. Selector switch S_1 must be in the correct position for the output terminals being used. This is because the voltage at the low-ripple terminals is lower than that found at the normal output terminals and the voltmeter must be switched to the correct line.

-30-

MARS MAY SCHEDULE

WITH the presentation of its May Speaker Schedule, the First U.S. Army MARS SSB Technical Net will wind up its activities until September of this year.

The Net meets on 4030 kc. each Wednesday at 9 p.m. (EDT). The schedule of speakers for May includes the following discussions:

May 4—"Antenna Panel" by Warren Offutt, Engineering Manager; Lorne De Size, Group Leader; and Bruce Woodward, Engineer, Airborne Instrument Labs, Inc., Melville, New York.

May 11—"Frequency Control" by Dr. Gernot Winkler, Scientist, USARDL, Fort Monmouth, New Jersey.

May 18—"Communication Electronic Needs of the Future," by Dr. John V. Harrington, Division Head, and Dr. Benjamin Lax, MIT Lincoln Laboratory, Lexington, Mass.

May 25—"Fundamentals of Oscillator Operation" by Robert W. Gunderson, Editor, Braille Technical Press, New York, New York.

S. Edwin Piller, A2KPQ, 157-32 20th Ave., Whitestone 57, N. Y., is director of the Net. Write him for additional details as required.

-30-

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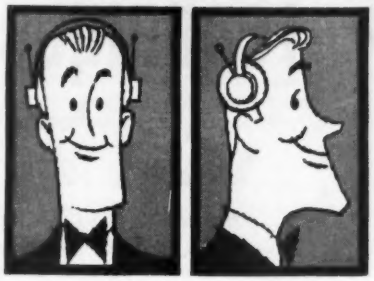

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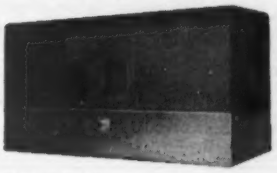

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Low-Noise Construction Techniques For Audio

By **JACK GREENFIELD**

A check-list for the kit builder and audiophile who wants his gear to be as noise-free as possible.

THE signal-to-noise ratio of a high-fidelity audio system may be improved considerably by following the preamp construction techniques outlined in this article. These techniques should assist the kit builder or enterprising audiophile with completed equipment in obtaining the ultimate in noise-free audio.

Random noise generated at the low-level magnetic phono preamplifier stage is amplified in the following stages, producing undesirable "hash" at the speaker. This vulnerable preamplifier stage can be made virtually noise-free by adopting the following construction techniques—which, incidentally, involve no changes in electronic design.

Parts Substitution

1. Replace the conventional-type electron tube which is generally supplied in the equipment by an equivalent low-noise type.

The reasoning behind this is that low-noise tubes are built more carefully. Supports and mechanical structures are re-inforced to minimize the possibility of microphonics. The control grid is usually plated with gold or a similar noble metal to reduce any irregularities in the grid structure which might adversely affect the passing stream of electrons. Heater-to-cathode design is such to minimize leakage. Heaters are wound and tapped precisely to provide maximum hum-bucking effect.

2. Replace paper dielectric coupling capacitors with plastic film dielectric units. Pick capacitors rated at a higher voltage than the paper dielectrics in the original circuit.

Plastic film dielectric capacitors have a very high "figure of merit" compared to their paper dielectric equivalents. This means that plastic film dielectric capacitors are less "lossy" and tend to couple more of the applied signal energy rather than to dissipate it in the dielectric. The use of higher voltage ratings decreases the possibility of signal energy losses and noise generation due to corona discharges (ionization of the dielectric). In addition, these high-voltage plastic film units are often physically smaller than their paper counterparts, contributing to a more orderly parts layout and simpler wiring.

3. Replace conventional carbon composition or film resistors with non-inductive wirewounds.

Experiment has shown that non-inductive wirewounds have lower noise figures than equivalent carbon or film resistors. The reason probably lies in the superior thermal properties of the materials used in the wirewound type since noise is due to thermal agitation.

4. Replace conventional fiber or plastic tube sockets with glazed ceramic types.

Fiber materials and many plastics are "lossy" insulators which tend to provide leakage paths between tube pins when used in tube sockets. Although some plastics have excellent properties in this respect, others are "dogs." Since plastics used in sockets are difficult to identify without resorting to extended chemical analysis, the safest bet is to use a glazed ceramic socket. Glazed ceramic sockets are easily procured, easily identified, and have excellent low-loss characteristics.

5. Discard conventional tube shields as they prevent heat dissipation and contribute to premature mechanical failure of the tube's structural elements which results in a microphonic tube.

Preamplifier chassis that are otherwise well shielded (See Point 13) should fare well in the hum pickup department without resorting to an individual tube shield. If trial or tests indicate better performance is obtained with a shield, use one of the newly developed blackened-heat-conducting inserts in the original shield. After applying the insert, be sure to place it in intimate contact with the shield-supporting structures of the tube socket in order to insure proper heat dissipation.

Special Handling Techniques

6. Do not use magnetized screwdrivers or other magnetized tools in assembling preamplifiers.

Accidental magnetization of susceptible parts may produce permanent magnetic fields within the structure of the preamplifier. These magnetic fields can easily introduce unwanted noise voltages into sensitive circuits by interacting with fields produced by normal circuit operation.

7. Scrape chassis to remove paint, anodized finishes, or natural oxide deposits at all points to which a bolted or soldered connection will be made. This is especially important in these days of

the very slick "furniture" cabinetry.

Paint, anodized finishes, and natural oxide deposits are all insulators. They are undesirable wherever intimate metal-to-metal contact is required. For example, in order for the cabinet of the preamplifier to be used as a shield, continuous metal contact is required. Another point that is often vulnerable to trouble from this source is the ground return connection at the signal input jack. This should be carefully checked.

8. Use tooth-type lockwashers at all connections made by bolting to the chassis. Re-inforce these connections by soldering wherever possible.

Tooth-type lockwashers are designed to bite into the metal of the chassis. Their use insures that an adequate metal-to-metal contact will be established. Soldering to the chassis is accomplished most efficiently with a heavy-duty 100-watt soldering iron and 60/40 rosin-core solder.

9. Remove the connector in the tube socket that corresponds to the grid pin of the preamplifier tube. Cut open the base of the socket at the grid pin position to accommodate a preamplifier tube with a permanently affixed grid lead.

Removal of the connector is easily accomplished by drilling (1/16" drill) into the recess at the top of the socket that is to accept the tube grid pin. When the drill has "chewed up" the connector it will come up against the hard glaze ceramic of the socket and will no longer feed. Stop the drill. Turn the socket over and shake out the remains of the connector. The pin that remains at the base of the socket may be pulled out with a pair of pliers. Place the socket, held upside down, in a vise. Insert the tip of a jeweler's screwdriver into the small rectangular hole from which the base pin was removed. By rapidly jerking the screwdriver downward a piece of the ceramic socket will be chipped away and a hole will be exposed at the grid connection point.

10. Connect a thin bare hookup wire lead to the preamplifier tube grid pin.

Scrape and tin the preamplifier tube grid pin and the end of a piece of thin bare hookup wire. Use 60/40 rosin-core solder. Scrape excess dried flux from each. Coil the tinned end of the wire securely around the grid pin, making the best possible mechanical connection. Bring a freshly tinned soldering iron into contact with the joint at the grid pin. When solder flows freely at the connection, remove the iron. If this step and the preparation of the tube socket have been properly executed, the tube will slip into place in the socket with the soldered-in-place grid lead protruding through the prepared opening in the socket base. This technique is based on the fact that connectors (particularly at tube sockets) are, by and large, the greatest source of noisy intermittents. In transistor work, where extremely low signal levels are common, sockets are frowned upon and only soldered-in connections are considered reliable.

11. Before finally installing the preamplifier tube, wash the tube carefully in liquid detergent solution. Rinse with alcohol followed by fresh water. After the tube dries handle with a clean, lint-free cloth.

Tubes often become coated with a film of solder or fine metal particles when subjected to normal abuse at the bench during construction projects. To insure that wasteful leakage currents are not set up in paths established by conductive films deposited on envelopes, tubes should be washed.

12. Make tight mechanical connections for all wiring associated with the preamplifier stage.

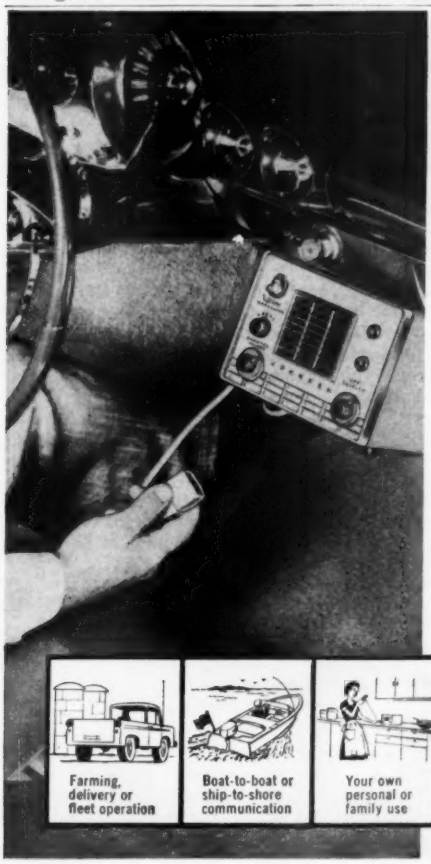
This is a standard technique that cannot be overemphasized as poor connections are a notorious source of noisy intermittents.

13. Keep all ground-return connections as short as possible.

Short ground-return connections will minimize the possibility of picking up stray interference and will reduce undesirable inductance to a minimum.

14. Surround the preamplifier stage top and bottom with a perforated or louvered conductive shield. Employ the techniques for mechanical assembly as discussed previously.

The chassis shield is positive insurance against pickup of stray noise from radiated electromagnetic energy. —30—



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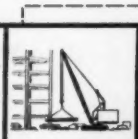

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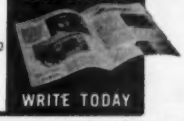

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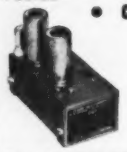

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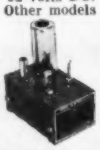

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Packaged Circuits

(*Continued from page 38*)

duction product, although higher densities may have been achieved in development work.

A truly distinctive application of the packaging technique is the four-stage transistor amplifier shown on this month's cover and also in Fig. 13. Requiring only input and output transducers plus a power source to function as a complete unit, it is useful in the design of hearing aids and a number of other devices. Fig. 13 indicates the construction and sequence of assembly. The steatite ceramic base disc, only ½ inch in diameter, has eight resistors and other circuit components screened on. To the opposite side of this plate from that shown in the first step, four transistors and one capacitor are connected. Four pie-shaped *Centralab* "Ultra-Kap" ceramic capacitors are then added, sandwiched between two pieces of insulators, layered above the transistors. Another ceramic disc capacitor is added and all capacitor leads are brought out through the holes on the periphery of the base plate. Finally, this assembly is sealed in a metal container.

Servicing

From a service technician's standpoint, packaged electronic circuits present relatively few problems in themselves. The degree of reliability is such that, when one goes out, the source of the trouble is probably elsewhere than in the package itself. However, since they do require replacement, PEC and other packaged circuits for radio, TV, and hi-fi can be obtained from electronic parts distributors.

Evidence of physical damage, such as displacement of the unit from its usual position in the equipment or an indication that something has been dropped on it, are about the only cases where the service problems are in the package itself.

Damage to a packaged electronic circuit is usually the result of a defective component elsewhere in the set. The shorting of a tube or a capacitor external to the packaged electronic circuit is the usual cause for the burning out of a resistor or capacitor in the package. Open circuits within the packaged electronic circuit simply do not exist since the conductors consist of silver bonded to ceramic.

Packaged electronic circuits have a "built-in" signal to indicate when one of the components has burned out. The heat generated by a resistor or capacitor in the process of burning out is sufficient to change the color of the encapsulation material permanently. The material is normally a light tan. The heat from the burned out unit changes it to a dark brown color, which shows up as a spot on the coating. In the case of bypass or coupling capacitors, a heavy surge of current can actually fracture the plate and the encapsulation material.

Since the trouble does not normally originate within the packaged electronic circuit, its correction requires that the technician locate the original cause of the defect to avoid recurrence of the service problem. To determine what tube or capacitor might be causing the circuit difficulty, one should trace the circuit in the usual manner and test to locate the defective resistor or capacitor in the package. This can easily be done by meter readings at the packaged circuit leads.

Since all published schematics of or-

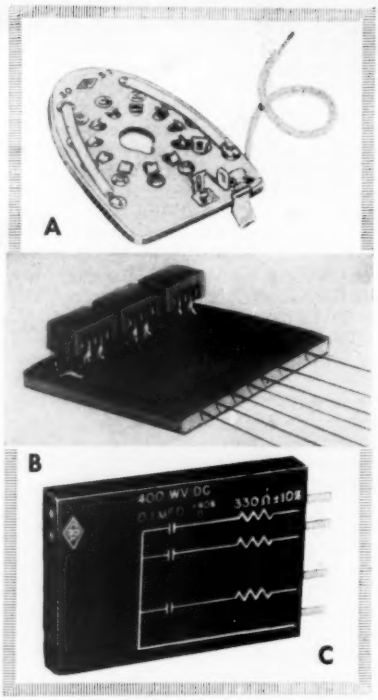

Fig. 14. PEC variety: 20-resistor network (A) built into socket, 3-stage amplifier with tube sockets (B), and plug-in RC network (C) for use in computer.

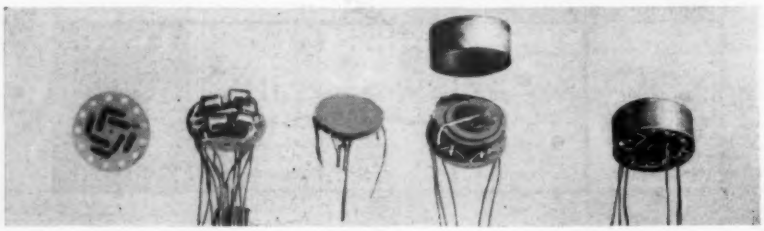

Fig. 13. Assembly sequence of 4-stage transistor amplifier featured on cover.

iginal set manufacturers clearly mark the package and components that are included, it is a simple matter to check the PEC internally. The components that are in the package are enclosed in a dotted or dashed line box. An examination of the schematic will show which contact points should be disconnected to isolate the package from the circuit. Usually, only one or two leads need be cut so that the package can be tested while it is still in the equipment. Wire leads should be unwrapped to retain their original length. Units with tab leads, such as used on printed-circuit boards, should be cut half-way between the board and the package and bent apart. It is not necessary or advisable to remove that package since it may still function after the original trouble is corrected.

Checking for a burned out resistor or capacitor is done in the usual manner and they show up in exactly the same way as would individual components. Where a resistor and a capacitor are in series within the package, they cannot be tested individually; however, under these circumstances, the resistor rarely burns out. It is almost impossible to pass enough current through the series resistor to damage it. A leaky capacitor will show up as a resistance reading across the total series circuit.

It may be advisable to further check the capacitors with a capacitance bridge. A word of warning is in order if the capacitors are being checked with one of the inexpensive capacitor checkers. These units generally use a 60-cycle bridge, while most ceramic capacitors are normally checked and rated at 1000 cps. If the equipment has a built-in oscillator, it should be used at the 1000-cycle signal in checking the capacitors. If the checker is the 60-cycle type, the power factor of the capacitor may be considerably higher than expected, and it should not be assumed that the capacitor is defective purely on the basis of its power factor alone. This is true of all ceramic capacitors whether they are part of a package or are individual components in the equipment. Resistors in parallel with capacitors are often reflected as an increase in capacitance on inexpensive meters and this should be taken into consideration in checking the capacitor.

Future Developments

What is the future of packaged electronic circuitry? Answering this question is tantamount to asking what is the future of electronics. Of this, however, one can be sure: packaged electronic circuitry is a permanent part of the electronic scene. Its use will become more and more widespread, its applications more and more varied, its forms more and more versatile. Just as the development of the technique opened the door to electronic miniaturization, so the refinements will change the face of electronics and expand the borders of technology. —30—

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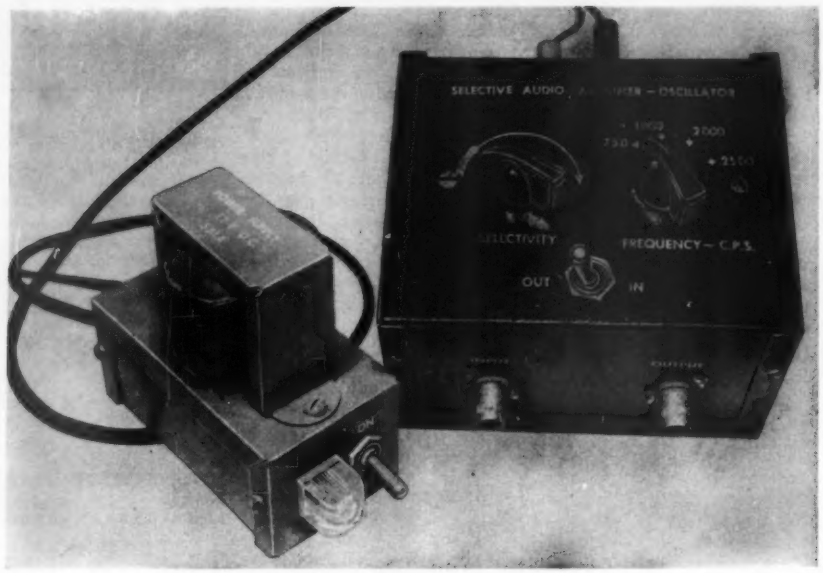


View of the compact "Q" multiplier with associated power supply.

Transistor Audio "Q" Multiplier

By DAVID STONE / Selective audio amplifier-oscillator reduces c.w. QRM, generates tones, can be used for selective signalling.

A SURPRISING variety of services can be performed by this transistorized oscillator—selective amplifier, or "*Q*" multiplier, in the audio-frequency range. It is a welcome addition to test equipment using audio oscillators and it will operate as an audio signal generator by itself. This unit can be used for code-copying, to peak a desired signal above the level of interfering signals. The "*Q*" multiplier can be used in selective signalling systems to operate a relay amplifier when it receives a specific audio frequency. These are a few of the applications to be treated in detail later and will surely suggest others.

Theory

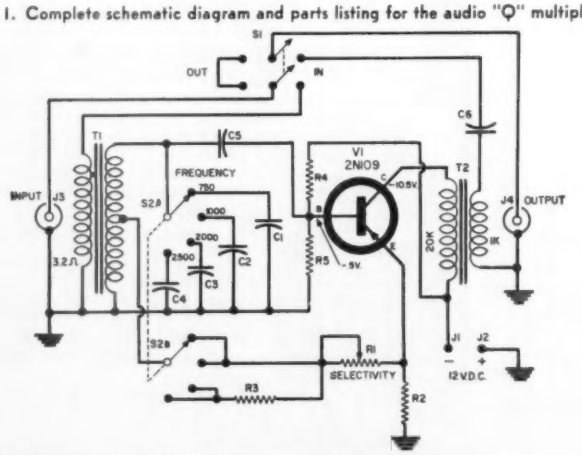
The "*Q*" multiplier is an audio-voltage amplifier with controlled positive feedback (see Fig. 1). A portion of the output voltage appearing across the emitter resistor R_2 is fed back through the feedback potentiometer R_1 to the center-tap of transformer T_1. Transformer action inverts the phase of the feedback voltage to add it to the input signal at the base of the 2N109. R_1, the "Selectivity" control, varies the amount of feedback voltage to set the circuit above or below the threshold of oscillation.

If R_1 feeds too much voltage back, the circuit will oscillate at a frequency determined by the input resonant *LC* combination formed by T_1's secondary and capacitors C_1 to C_4. The transistor's output is an excellent sine wave at this frequency when the feedback is set just above the oscillation threshold.

When the "*Q*" multiplier is used as a selective amplifier, R_1 is adjusted to decrease the feedback just below the oscillation threshold. An incoming audio signal, at the same frequency as the resonant frequency of the input *LC* combination, will be sharply peaked and amplified at the output. The "*Q*," or sharpness of resonance of the tuned *LC* circuit, is "multiplied" by this action because it provides maximum amplification and minimum bandwidth at one frequency.

It is best to have a high "*Q*" inductance to start with, to obtain the sharpest possible peak. High "*Q*" inductors are fairly expensive to come by but a reasonably good inductance can be obtained by altering the core of a standard push-pull output or interstage transformer. When the core's I-laminations are removed, the transformer's "*Q*" is raised considerably and the re-

Fig. 1. Complete schematic diagram and parts listing for the audio "Q" multiplier.



R_1—1000 ohm carbon or wire-wound linear taper pot
R_2—10,000 ohm, ½ w. res. ± 10%
R_3—1000 ohm, ½ w. res. ± 10%
R_4, R_5—220,000 ohm, ½ w. res. ± 10%
C_1, C_2—.1 µf., 200 v. capacitor
C_3—.05 µf., 200 v. capacitor
C_4—.01 µf., 200 v. capacitor
C_5—.005 µf., 200 v. capacitor
C_6—1 µf., 200 v. capacitor
J_1, J_2, J_3, J_4—Audio and power jack (constructor's choice)
S_1—D.p.d.t. toggle switch
S_2—D.p. 4-pos. rotary switch
T_1—Push-pull audio output trans., 6000-7000 ohm pri. to 3.2 ohm sec. (Thordarson 22S47 or equiv., see text)
T_2—Transistor interstage trans., 20,000 ohm pri. to 1000 ohm sec. (Thordarson TR-14 or equiv., see text)
1—Chassis (Bud "Minibox" CU-3005)
V_1—"p-n-p" transistor (RCA 2N109)

sulting inductance is perfect for use in this "*Q*" multiplier (see Fig. 2).

The collector circuit uses a transistor interstage transformer to couple the oscillating or amplified signal to output jack J_4. The "In-Out" switch S_1 is used to bypass the incoming signal directly to the output jack when the "*Q*" multiplier is not being used. Capacitor C_6 is not shown in the photographs because it was added later to handle a wider range of output loads. It should be installed permanently in a newly constructed unit.

The "*Q*" multiplier requires 12 volts at 2 milliamperes on the lower frequency ranges with a slight decrease in the current drain at the higher settings. This nominal power requirement can be met with a standard miniature 12-volt battery or an a.c.-powered supply such as the type diagrammed in Fig. 3. It is a voltage doubler utilizing two 1N69 germanium diodes for rectification with a standard 6.3-volt a.c. filament transformer. This combination produces about 15 volts d.c. and the 2500-ohm potentiometer drops this to 12 volts. The filament transformer can be eliminated if the "*Q*" multiplier is to be used exclusively with equipment employing 6.3-volt-filament tubes. The points marked "X" in the schematic can be connected to the filament lines in the equipment.

If possible, construct the power supply on a separate chassis to eliminate any power-line hum pickup from the amplifier circuit. Also, a separate power supply will be handy for use with other transistor gear. If the power supply is included in the same enclosure, care should be taken to keep the power components away from the rest of the circuitry.

Construction

The unit uses standard components without critical tolerances and many constructors will undoubtedly have most of the parts on hand in the spare-parts box.

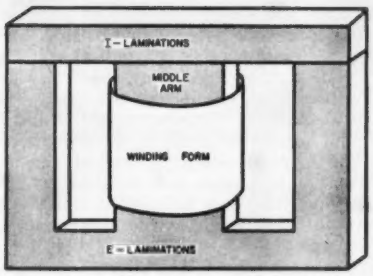
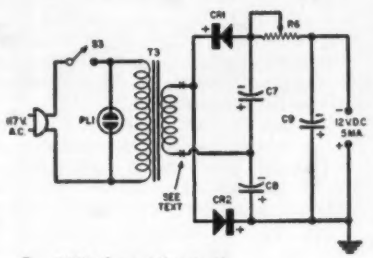


Fig. 2. Construction of transformer used.



R_6—2500 ohm pot (see text)
C_7, C_9—50 µf., 10 v. miniature elec. capacitor
C_8—15 µf., 25 v. elec. capacitor
S_3—S.p.s.t. toggle switch
PL_1—117-volt neon lamp
CR_1, CR_2—1N69 germanium diode
T_3—Fil. trans., 117 v. pri., 6.3 v. sec. (Tried F13X or equiv.)

Fig. 3. Voltage-doubler power supply.

The input transformer T_1 must be dismantled by removing the metal mounting frame. This exposes the winding form and the I-laminations positioned on top of the E-laminations. Remove the I-laminations and discard them with the mounting frame. Loosen the winding form so it can be slipped up or down the middle arm of the E-laminations, then return it to the center of the arm for calibration purposes later.

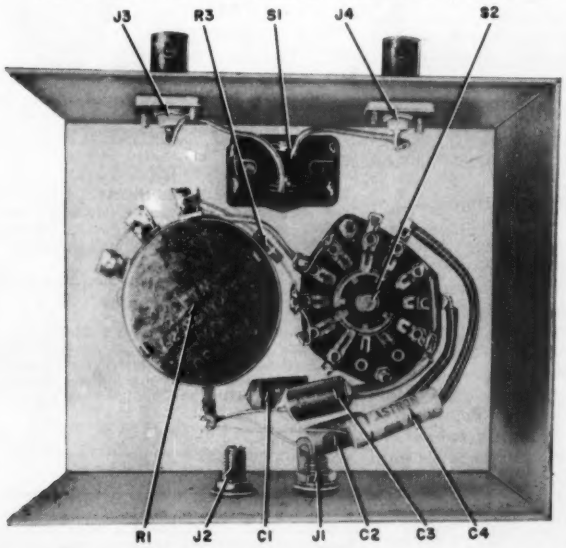
The mounting of transformer T_1 is the only critical aspect of the whole layout. It must be mounted on a non-metallic surface or chassis made of wood, plastic, or phenolic and placed so that it is as far as possible from the metal sides of the enclosure. This is done to keep the "*Q*" of the transformer from being lowered by the presence of metal near the winding form. This construction uses a 4 x 2 x ¼ inch phenolic board which is large enough to mount T_1, T_2, the transistor socket, all the resistors, and capacitors C_5 and C_6. Transformer T_1 can be taped to the board, or mounted with a heavy cardboard strap or very small metal angle brackets. Most of the circuitry was installed on the board and the board was mounted layer-fashion in the enclosure, as is shown in the photograph below.

Potentiometer R_1, switches S_1 and S_2, the input, output and power jacks are installed in the sides of the enclosure and the phenolic chassis is mounted above these components with long stand-offs. If the unit is built in this manner, the wiring can be completed in both layers, the board can be mounted, and the few remaining connections completed between the two layers. Wire the "Sensitivity" control so its resistance *decreases* with clockwise rotation of the shaft, and keep the input and output wiring to T_1 and T_2 as far apart as possible.

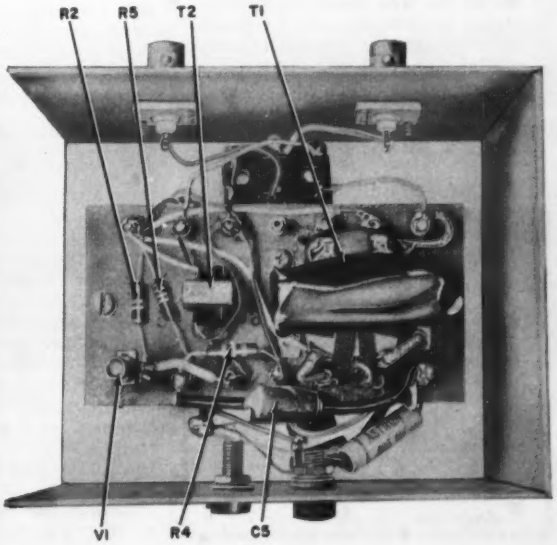
Calibration

Connect a pair of headphones to output jack J_4 and rotate the "Selectivity" control fully clockwise. Set the 2500-ohm dropping potentiometer in the power supply to mid-range and *carefully check for proper polarity* of the power connections to the "*Q*" multiplier before turning on the power. When power is applied, an audio tone should be heard immediately. If not, check the wiring of R_1 to make sure all the resistance is out of the circuit, or

View of components mounted directly under the top panel of unit.



Wiring of component board mounted under the top panel of unit.



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check all wiring connections and test for a possible defective transistor.

Listen for audio output at all settings of the "Frequency" control, then return it to the lowest frequency setting. Place a voltmeter across J_1 and J_2 and adjust the dropping potentiometer for a 12-volt input. If desired, the potentiometer can be replaced by its equivalent value in a fixed resistance, 1-watt rating, after the calibration is completed.

Rotate the "Selectivity" control counterclockwise on all frequency settings. This should cause the unit to go in and out of oscillation and the tone will appear and disappear. Return the "Frequency" selector to the 1000-cycle setting and advance R_1 to just above the oscillation threshold.

Connect the "Q" multiplier's output to the vertical input of an oscilloscope and connect a calibrated audio generator to the scope's horizontal input. Set the calibrating generator's dial to 1000 cycles and carefully slide the winding form on T_1 up or down the middle E-lamination arm until an ellipse or circle appears on the scope. When this is obtained, carefully glue or tape the winding form permanently into position without disturbing its location.

The other settings of the "Frequency" selector can be measured with the same setup. They may not be exactly the frequencies specified on the schematic due to tolerance difference in the capacitors or layout but they will be fairly close. The exact frequencies can be obtained with slight addition or reduction of the capacitor values in the LC combination if this accuracy is needed. Mark the exact frequencies on the panel or round them off to the nearest full number.

The selective amplifier action can be checked by rotating R_1 just below the oscillation point. Inject a signal from the calibrating generator at the input jack, at the same frequency specified by the "Frequency" selector. The output voltage, observed on the scope, will be sharply peaked at this frequency and will sharply decrease when the calibrating generator's dial is moved above and below the selected frequency.

Uses

This transistorized audio "Q" multiplier has a good many interesting and highly useful applications. Some of these are described in the remainder of this article.

For code copy, connect the "Q" multiplier to the short-wave receiver's headphone or speaker output and turn the receiver's audio gain control down so that no signal is fed to J_2. Throw S_1 to the "In" position, set the "Selectivity" control clockwise to the oscillation point and back it down to just below the oscillation threshold. This setting will produce the narrowest bandwidth amplification. Turn the receiver's gain control up and note that the signals sound "canned." Throw S_1 to "Out," tune in a code station, then flip it back to "In." Carefully tune the b.f.o con-

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trol. When the frequency of the code signal is the same as the *"Q"* multiplier's frequency setting, the signal will peak sharply. It will take practice to obtain this peak point, for it is sharp and easily passed. It will be necessary to re-tune occasionally if the receiver's front end or b.f.o. is not too stable. Keep the receiver gain control down to a comfortable level, lean back, and enjoy some interference-free copy.

The oscillator-amplifier can be used to increase the sensitivity of a detector in an impedance bridge or other type of a.c. bridge which uses an audio signal for operation. The signal is generally 1000 cycles and the selective amplifier can be connected in series with the detector to obtain much sharper readings. It can also be used as a 1000-cycle oscillator to furnish a signal to the bridge itself.

The selective amplifier's output can be fed into a diode detector and relay amplifier to operate only when its specific frequency is received. Several selective amplifiers can be built to operate at various frequencies and placed in parallel on a signal line. Then each relay unit will work only when its frequency is sent down the line.

It can be used for spot frequency measurements, if the unknown signal to be measured falls into the same frequency settings of the *"Q"* multiplier. An output meter connected to the unit will indicate maximum response when the unknown and selective-amplifier's frequencies coincide. Two selective amplifiers tuned to the same frequency and connected in series will amplify at even narrower bandwidths.

Finally, the unit operates very nicely as a general-purpose audio signal generator when the "Selectivity" control is turned up slightly above the oscillation threshold. The output waveform is excellent and the output voltage is approximately 3 volts peak-to-peak.

Other audio applications will come to mind for this versatile, compact unit. It is a useful item to be added to a collection of equipment for experimental or testing purposes whenever an audio filter, selective amplifier, or oscillator is needed. —30—

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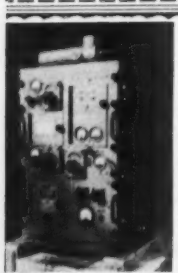

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(*Continued from page* 58)

so for other tin/lead combinations. Those containing substantial amounts of both tin and lead become mushy or plastic at 361° all right; but the temperature at which they become completely liquid depends, as we have already seen, on the precise tin/lead ratio. The temperature span between where a solder softens and where it becomes completely liquid is called its *plastic range.* A 40/60 composition—the first number mentioned is always tin—starts to soften at 361° and becomes completely liquid at 460°. The plastic range of 50/50 solder lies between 361° and 414°; that of 60/40 solder between 361° and 370°."

"It seems to me that 63/37 eutectic mixture is the ideal solder. It melts at a minimum temperature and sets quickly. So how come the 40/60 composition is used in radio work?"

"Economics. Because of the word 'tin can'—which is really a steel can with a very thin tin plating—most people think tin is cheap. It's not. In fact it costs about six times as much as lead. In radio work we're not concerned with the little extra heat needed to melt the 40/60 solder; so, since it makes just as good a connection for all practical purposes as the eutectic composition and is less costly, it's the one used. If we were soldering pewter ware and had to be careful not to melt the stuff we were soldering, we'd use 60/40 solder. On the other hand, in filling in car fender dents where we had to wipe the solder on and shape it before it cooled, we'd likely use a 15/85 solder with a plastic range of almost 200°."

"My, you are full of information!"

"Oh I know lots more," Barney boasted. "For instance, I know the flux in solder does three jobs: (1) removes tarnish or metal oxide, (2) prevents other oxide from forming while the metal is raised to soldering temperature, and (3) lowers the surface tension of the molten solder so it can wet the metals and penetrate their pores, as it must. Resin fluxes, of course, are the only ones generally recommended for electrical use.

"And finally, I know the strength of a soldered connection lies in the thin solder film—preferably about .004-inch thick—in which the alloy action between the metals being soldered together takes place. Once this film has been formed, adding more solder is useless waste."

"Seriously, Carrot Top, I'm proud of you for coming up with all this dope," Mac said. "I've read dozens of articles on *How* to do a good job of soldering, and I think we both can make a respectable solder joint; but you have told me a lot I didn't know about the *Why* of soldering. And I have always been convinced that until you have mastered both the *How* and understood the *Why* of a thing, you can't say you know it."

—30—

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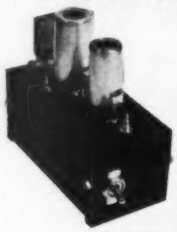

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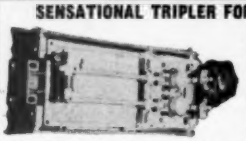

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LESS TUBES 14.95

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ALMQUIST ENGINEERING, Dept. EW-5, MILFORD, PA.

The "Bi-Phonic Coupler"

(*Continued from page 47*)

be both a sound radiator and a picture.

For the present, however, we must recognize that in order to maintain the stability of the diaphragm against the ravages of humidity and weathering, the surface of the panel had to be treated as a piece of fine furniture. If one wanted to paint a picture on a finely finished piece of wood which has been sanded, filled, varnished, and buffed, then he is at liberty to do so, but only to the extent that the original treatment of the panel is not destroyed.

The system can also serve as a room divider, either by itself or standing on ready-made metal-shelved room dividers or suspended between floor-to-ceiling pressure posts. The units may also be used as "sound chandeliers" with, perhaps, a lighting source between them and the ceiling so that indirect lighting is obtained while, at the same time, sound is produced directly downward and simultaneously scattered from the back of the speaker up to the ceiling and back into the room.

Another application would be to mount the speakers within the joists of the wall so that the speaker is flush with the wall. Since the speaker is only 4½ inches wide, it may actually be used to radiate from both directions into adjoining rooms. If it is desired to radiate only into a single room, then the back of the speaker simply transmits the sound into the large cavity up and down between the joists and the wall structure.

It is also possible to employ the speaker as the actual walls of equipment cabinets, thus saving considerable space (and expensive woodworking) over the original cabinet structure. One unusual application of this speaker involves its installation into the headboards of twin beds, providing stereo reproduction in the bedroom! —30—

TAPE RECORDER FLUTTER

By A. VON ZOOK

VIBRATION in tape recorders, in the form of flutter, is a frequent troublemaker. Locating exactly which drive wheel or idler is responsible can often be tricky. However, the localization procedure can be made quite easy, in most cases, by a relatively simple technique. Use a long, thin screwdriver, permitting its blade to rest on each idler or drive wheel while the latter is in motion. Place your ear next to the handle of the screwdriver. A rotating member that is out of round will produce a clearly heard thumping noise.

In some cases the thump will be heard at more than one wheel, since the motion causing it can be transmitted from one element to another in the drive system. Where this occurs, first suspicion falls on the wheel where the audible thump is most pronounced. After this is replaced, the check is repeated. —30—

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- The advertised tubes are not necessarily new, but may be electrically perfect factory seconds or used tubes—each is clearly so marked.

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force, and the signal from the crystal is proportionate to this force. Because the crystal is a high-impedance device, we have shown it feeding a cathode-follower, which then drives an amplifier and remote indicator.

Two other types of dynamic transducers are shown in Fig. 9. In the inductive vibration transducer (Fig. 9A), a small mass vibrates and, through a reed linkage, drives the magnetic core of a coil. When a magnet moves through a coil, a voltage is generated that varies with the speed of motion. An amplifier is usually used to drive a remote recorder. Transducers such as this are widely used in missile testing, aircraft instrumentation, and industrial processes where vibratory motion must be monitored.

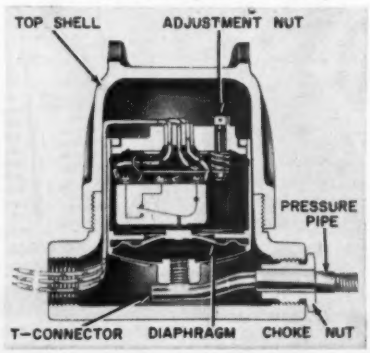
The capacitive accelerometer shown in simplified form in Fig. 9B is basically the same as the capacitive pressure transducer of Fig. 8A except that the inner plate (mass) moves and its motion depends on the acceleration exerted on it. The change in capacitance is proportional to acceleration, and the output will be in the form of a change in frequency.

We have described only a sampling of what the reader will encounter in the industrial electronics field. Each particular installation requires its own types of transducers, and one has to study the entire system carefully as well as the detailed manufacturer's data in order to be able to repair or adjust any part of it.

Repair and Adjustment

Anyone servicing industrial electronic equipment will understand the need for a knowledge, not merely of electronics, but also of the adjoining devices. While the electronic technician is not expected to repair hydraulic, pneumatic, or electric-power equipment, he must at least know something about it. In servicing transducers, the same holds true. Before deciding that the trouble lies in the transducer, one must understand the entire system sufficiently to make a few pertinent checks. If the trouble seems to be in

Fig. 10. Detail of a pressure-controlled Microswitch (Barksdale Valve).



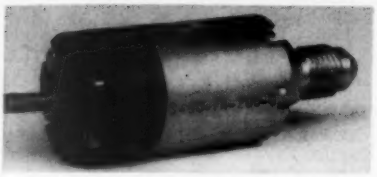


Fig. 11. Transformer type linear-motion transducer made by Vinson Mfg.

the transducer, the question usually arises whether it is in the electronic or the mechanical portion. Either a cracked diaphragm or a shorted transformer winding can result in transducer failure, but the repair and the possible effect on the other components will be quite different in each case.

Electronic technicians will have no trouble testing the electrical portions of transducers because simple ohmmeter checks will show up open coils or shorted capacitors, provided we know what kind of electrical device we are testing.

Most transducers are housed in rugged sealed containers and are often difficult to take apart. We can get some idea of the internal construction of typical transducers from the diaphragm-actuated microswitch in Fig. 10. Note that the various pieces are all screwed together. In order to adjust the tripping pressure, the top shell has to be unscrewed and then the spring-loaded adjustment nut is turned to raise or lower the switch itself. If trouble in the diaphragm section is suspected, the choke nut holding the pressure pipe in place must be removed and then the entire unit slipped out of its housing. Finally, the *T*-connector to the diaphragm cavity must be unscrewed so that the diaphragm section itself can be cleaned out.

Because clogging of the pressure section of a transducer is one of the most frequent troubles, the "Teleflight" Model 206 shown in Fig. 2 has a removable pressure chamber for easy cleaning. In most practical cases, the repair of a defective transducer will consist of cleaning and re-calibration, since serious defects such as open or internally shorted coils, or broken resistance elements, will require exact replacement. In replacing transducers, a calibration of the entire system must be performed in strict compliance with manufacturer's instructions.

Conclusions

Transducers, as the sensing devices of automation, cover a very wide field in themselves. This article has dealt with some representative types, their operating principles, and has included a description of the electronic circuitry usually associated with each type. The last word on their repair and adjustment is a subject worthy of a book. However, important basic hints have been presented here.

As to complete familiarity with transducers, each technician acquires this through experience with the specific types he must handle. —30—

What's New in Radio

GENERAL-COVERAGE RECEIVER

Heath Company, Benton Harbor, Mich. has added the "Mohican" general-coverage receiver to its line of ham gear in kit form.

This new Model GC-1 features an all-transistor circuit powered by 8 long-life standard flashlight cells. The circuit also incorporates ceramic i.f. transfilters; a built-in telescoping 54" whip

antenna; flywheel tuning, tuning meter; and a large, easy-to-read slide-rule edge-lighted dial.

The receiver covers 550 kc. to 30 mc. on five bands. Electrical bandspread is provided on the five separately calibrated ham bands and the 11-meter Citizens Band. The b.f.o. is tuned through the variable capacity effect of a diode and is adjustable by means of a front panel pot.

The GC-1 can be converted from battery to 117 volt a.c. operation by means of an accessory power supply (XP-2).

TEST ADAPTER

Laik Electronics Co., 311 Hickory St., Kearny, N. J. is now offering a new series of test adapters which have been specifically designed for engineers, technicians, experimenters, and hobbyists.

Currently available in three versions,

for 7-pin miniatures, 8-pin octals, and 9-pin miniatures, the new adapters are designed to permit voltage and resistance measurements even on the most crowded chassis. Breaking the circuit is accomplished by loosening the screw in the circuit or circuits under test and inserting meters or components between the upper and lower lugs. No

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1N1455	25 amp. 200 volts	3.50
1N1456	25 amp. 300 volts	4.00
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special leads, jacks, or plugs are necessary. For semi-permanent installation, components may be soldered to the adapter lugs.

Terminals are color-coded for easier and faster testing. For a data sheet giving complete information and prices, write the manufacturer direct.

HANDY CIRCUIT TRACER

Doss Electronic Research Inc., 820 Baltimore, Kansas City 5, Mo. has

added a new unit to its probe instrument line.

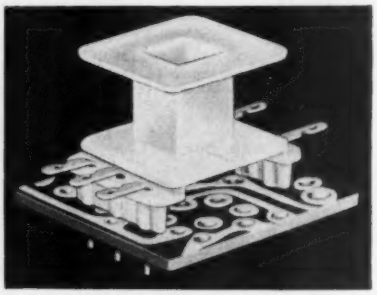
Known as the "Noy-Z-Ject" Model D-800, the new instrument is an r.f.-i.f.-audio pulse generator. It is self-contained and transistorized. It is designed to be used in troubleshooting r.f., i.f., or audio circuits. The circuit is a blocking oscillator with a pulse generator waveform output. The oscillator frequency is approximately 1000 cps which provides an audible output at this frequency in audio circuits.

The unit may also be used for tracing video, printed circuits, etc. and is especially useful in checking transistor radios. Complete instructions are included with the instrument which is housed in an attractive red and grey case.

PC COMPONENTS

American Molded Products Company, 2727 W. Chicago Ave., Chicago 22, Ill. has developed a new printed circuit transformer and relay bobbin which is said to offer substantial savings for manufacturers.

The lugs are embedded in nylon for permanent location and the entire unit designed to prevent wire breakage.



While the unit shown in the photograph has been added to the firm's stock items, special bobbins can be made to the customer's specifications. According to the company, the new unit will eliminate the cost and assembly of the terminal board.

Manufacturers are invited to get in touch with Mr. A. Weyrich of the Engineering Department for samples and assistance on special requirements.

SHAFTS FOR FOREIGN GEAR

Centralab, a division of *Globe-Union, Inc.*, 900 E. Keefe St., Milwaukee, Wis. has recently introduced a new 0.235" diameter aluminum shaft for use with its Model AB controls to permit the units to be used as replacements in foreign equipment.

Known as the AK-29 shaft, it is specially designed for applications in foreign radios, tape recorders, and hi-fi equipment where the standard ¼" shaft will not fit. This aluminum shaft is full round and measures 2 9/16" in length from the bushing.

Local distributors are now stocking this item.

COMMUNICATIONS MIKE

Electro-Voice, Inc., Buchanan, Mich. has announced the development of a new microphone which is designed especially for communication service applications.

The Model 715 SR unit is designed to be hand-held and comes equipped with a hang-up bracket. A special ceramic element makes the unit suitable for extremes of temperature and humidity such as are encountered in use of Citizens Band radio, marine transceivers, industrial systems, emergency two-way radio and dispatching equipment.

The unit is a high-impedance type, has an output level of −55 db, and a frequency response range of 60-7000 cps. The case is constructed of rugged, die-cast zinc.

C-D SUBSTITUTION BOX

Cornell-Dubilier Electric Corporation, South Plainfield, N. J. is now making available a compact and convenient electrolytic capacitor substitution box, the Model CDE.

The new unit provides an instantly available choice of capacitances for substitution purposes in a wide variety of electronic and electrical applications within the ratings of the unit. Fifteen combinations of electrolytic capacitance are possible from 10 to 150 μf. in steps of 10 μf. at voltages up to 450. Two or more units may be connected in parallel to provide an almost unlimited range of capacitance.

Complete details and price are available from local distributors or literature can be obtained by writing the manufacturer direct.

4-CHANNEL CB UNIT

Vocaline Company of America, Old Saybrook, Conn. is now offering a new multi-channel version of its "Commaire" Citizens Band receiver-transmitter.

The new model, the ED-27M, has four separate channels to give the user the convenience and flexibility of a conference phone while providing uniform performance throughout the entire 22-channel class D band.

The ED-27M offers the same features as the company's ED-27 with an improved transmitter circuit for more effective range. The receiver is a crys-

tal-controlled, double-conversion superhet with a selectivity of 5 kc. at points 6 db down and a sensitivity of ±0.3 μv. The unit incorporates the company's patented "Silent-Aire" squelch circuit and a transistorized power supply.

Complete details on the ED-27M are available from the manufacturer on request.

TRANSISTORIZED TACHOMETERS

Electro Products Laboratories, 4501 N. Ravenswood Ave., Chicago 40, Ill. is now offering a line of transistorized tachometers having a dual function—measurement of speed without physical loading and control of associated circuitry such as overspeed and underspeed control.

The sensing device for the Model 7120 series is a magnetic pickup. Angular velocity of shaft projections or a rotating gear induce a signal in the pickup corresponding to frequency of revolution. The pickup's signal is converted by the tachometer to a d.c. current directly proportional to the frequency of the signal.

Instantaneous readings, in addition to control circuitry, are provided by a meter-relay unit whose scale is calibrated in rpm. Accuracy of indication is 2% of full scale. The meter has two pointers—one indicates rpm while the other, a control pointer, can be set prior to making a measurement to any value of rpm. Upon reaching this pre-set value, a relay used for controlling associated circuitry is activated.

For full details on this new "Electro-Tach" Model 7120 Series, write R. H. Novic in care of the company.

NEW V.T.V.M.

Century Electronics Co., Inc., 111 Roosevelt Ave., Mineola, N. Y. has added an a.c.-operated peak-to-peak vacuum-tube voltmeter to its line of test equipment for service technicians.

The new Model VT-10 features a unique "Multi-Probe" which does the work of four probes. With a twist of the tip, the probe can be set to function as a d.c. probe, a.c. probe, low-capacity probe, or r.f. probe. A special holder on the side of the case secures the "Multi-Probe" in place, ready for instant use.

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The circuit of the new unit features an advanced pentode circuit and employs a 6-inch, 100-μa. meter with four easy-to-read multi-color scales, and an amplifier-rectifier circuit with frequency-compensated attenuator.

The unit is housed in a grey hammertone steel case while a matching cover protects the instrument's face when being transported.

TRANSISTORIZED CB UNIT

Jetronic Industries, Inc., 4000 N. W. 28th Street, Miami, Florida is now offering a transistorized, hand-held CB radio which weighs less than four pounds and has been designed especially for plant maintenance crews and guards.

The "Spokesman" is powered by flashlight batteries and features a separate ultra-sensitive superhet receiver and three-stage transmitter. The circuit requires no tuning. Reliable communication between two of the units can be maintained at distances up to one mile while the base-to-portable range is 3 miles. A press-to-talk switch prevents accidental transmission. There is a volume control and self-contained telescoping antenna incorporated in the unit.

NEW SILICON RECTIFIER

Syntron Company, 606 Lexington Ave., Homer City, Pa. has announced the addition of the Style 31 double-diffused silicon rectifier to its line of power rectifiers.

The Style 31 is rated at 17 amperes average at 25 degrees C ambient on a

5" x 5" x 1/16" copper heat sink. Peak inverse voltages range from 50 to 400 volts in 50-volt steps.

A typical forward dynamic resistance of .009 ohm is achieved by diffused junction techniques.

6-METER CONVERTER

Globe Electronics, 22-30 South 34th St., Council Bluffs, Iowa is offering a new and improved version of its 6-meter converter.

The Series 6-PMC features improved circuitry to provide higher gain for greater sensitivity with better signal-

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to-noise ratio. The converter and cables are completely shielded to minimize leak-through of unwanted signals. The stable crystal converter with cascode r.f. stage and bandpass coupling is now available with two output frequencies, enabling the converter to be used with most types of communications receivers plus 6- or 12-volt auto radios for mobile use, at the option of the amateur radio operator.

The printed circuit construction simplifies and speeds kit assembly. The kits come complete with a 6U8, a 6BQ7, a crystal, receiver input cable, and power cable. The unit measures 3" x 5½" x 4½". There are four versions of the converter available—two assembled and two kit models. Write the manufacturer for a data sheet giving full details and prices of the various units.

SHOP TUBE TESTER

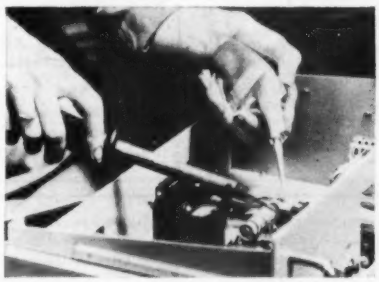
Mercury Electronics Corp., 77 Searing Ave., Mineola, N. Y. is now offering its Model #201 self-service tube tester which has been especially designed for installation in radio and television service shops.

Over 800 tube types can be checked in this tester with only two settings. Instructions on the panel are simple enough to permit any customer to handle his own tube testing chores. The easy-to-read multi-color 7½-inch meter scale indicates the condition of the tube immediately and without confusion. The unit tests for quality, shorts, leakage, and gas content.

The counter model is in hammertone gray and red and features a colorful illuminated display on top of the cabinet. The floor model includes a storage cabinet which holds over 400 tubes in removable trays. The trays have specially designed dividers and drawer sheets to control tube inventory and permit easy restocking. The storage compartment is equipped with a lock.

SOLDER DISPENSER

Products for Industry, 220 S. Rose Street, Los Angeles 54, Calif. has developed a compact and handy tool for those whose work or hobby involves soldering operations.



The "Kormat" is a wire solder dispenser with a push-button feeder that provides the correct amount of solder for every application. The unit offers a selection of attachments including straight or curved probes in several lengths for hard-to-get-at areas. The dispenser comes equipped with a 20-foot roll of 60/40 rosin core solder of .050" diameter. Flip action reloads the wire solder in seconds. The dispenser will feed solder wire from .028" to .074" in diameter.

For complete details and price, write the manufacturer direct.

REGENCY CB TRANSCEIVER

The *Regency Division of I.D.E.A., Inc.*, 7900 Pendleton Pike, Indianapolis 26, Ind. is now offering a new Citizens Band transceiver which features a double-conversion superheterodyne tunable receiver plus a transmitter featuring automatic modulation control.

The Model CB-27 employs a crystal-controlled first oscillator for receiver performance that approaches the stability and resettability of a crystal-controlled unit yet retains the flexibility of a tunable receiver, according to the company. Other receiver features include adjustable squelch, noise limiter, illuminated slide-rule dial, and a.v.c. The transmitter has automatic modulation control to prevent distortion-producing over-modulation. The transmitter provides the choice of two channels. The unit comes equipped with a crystal for one channel. Facilities are provided and the

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- **T61/AXT2 Television Transmitter with Mounting Bracket (Unused). $39.95.**
- **11 Meter Citizen Band Antenna, Spring & Base Assembly.** New. Ward Products Corp. Perfect for Mobile installation. 3 units reg. net for $17.50. Sale **$12.00.**
- **Scope Xfmr W.E. Pri: 115 V. @ 50/60 CPS.** Sec. (1) 1000 V. @ 8 Ma. (2) 6.3 V. @ 3.2 Amps. (3) 6.3 V. @ 2.1 Amps. (4) 5 V. @ 3 Amps. C.T. Electrostatic Shield. Size: 5 5/16"H x 4⅜"W x 3½"D. Wt. 11 lbs. Stock #KS8877. **$3.75.**
- **Public Address Unit:** In: 115 V. @ 60 CPS. Unused. Uses four 6L6's PP Parallel. **$65.00.**
- **6 KV RF Transformer.** Oil Filled. Herm. Sld. Diagram clearly stenciled on unit. 4½"Hx7"Wx6¾"D. Wt: 6½ lbs. Raytheon #WX-5394. **$3.95.**
- **Plate Transformer.** 1100-0-1100 VAC @ 280 Ma. CCS ratings. Pri: 120 VAC @ 60 CPS. Herm sld. new orgi. Raytheon ctn. 5½" H x 6¾" W x 4⅜" D. 25 lbs shipping wt. **$9.00.**
- **68" H Relay Racks.** 22" W Overall. D: 18". Unit has frt & rear doors. Used—good condition, needs touch up. Spg wt: 180 lbs via economical motor freight. **$29.95.**
- **Beautiful plastic raised relief maps.** 8 rich colors, 28½"x18½". Molded frame for easy hanging. Slide-O handy map index. Mountains stand up nearly an inch. Feel the earth's topography. A conversation piece. Ideal for den or Shack. Specify Map of U.S.A. or the World. **Both $9.95 each.** 5 lbs shg wt.
- **8 Mfd @ 1000 VDC Capacitors.** ½"x3¾"x6". 1 lb 6 oz. **$2.50.**
- **Sola—Monster Sola Constant Voltage Xfmrs.** Ltd. Qty. Type #30M814 (4 KVA) **$245.00.** Type 30M815 (5 KVA) **$295.00.**
- **New. Westinghouse 1N1169 Silicon TV Rectifier.** Replaces TV Selenium Rectifiers and gives you greater B plus voltage. **$1.20.**
- **FTR Vibrator Xfmr.** In: 25.2 V. (115 CPS). Out: 300 V. @ 100 Ma. **50¢.** Hammarlund Super-Pro Power Transformer. Pri: 115 or 230 V. @ 60 CPS. Sec. 435-0-435 @ 160 Ma. RMS. Fil. Sec: 6.3 V. @ 7 Amps, 5.0 V. @ 2 Amps, 5.0 V. @ 3 Amps. Wt: 20½ lbs. **$4.50.**
- **Hallicrafters SX-28A Replacem't Power & Transformer.** Pri: 115 or 230 VAC @ 50/60 CPS. Sec: 350-0-350 @ 200 Ma. Wt: 14 lbs. 6.3 @ 5 Amps., 5.0 @ 3 Amps. **$5.50.**
- **Dual Oil Capacitor** in one container 2 Mfd. @ 1000 VDC plus 6 Mfd. @ 800 VDC @ **$1.00.**
- **Small Hammarlund Super Pro Choke.** 120 Ma. DC. Res: 920 Ohms. Test V: 2500. Wt. 7 lbs. **$1.50.**
- **THORDARSON CHOKE SPECIAL.** 5 Hy 200 Ma. Herm. sld. Compact. Side insulators. 1600 V. insul. approx. 115 ohms DC res. 2½"x2½"x 3½". Wt. 2½ lbs. **$1.00.**
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- **Raytheon 8½ Amp. Choke.** For low-V., Hi-Current sel. or sil. pwr. supplies. Rated 0.02 hys @ 8.5 Amps DC. Test V. 1780 V. R.M.S. Unused. Wt: 37 lbs. Stock #CRP-47843. **$7.50.**
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- **SSB Low Capacity Fil. Xfmr.** Pri: 110 VAC 60 CPS. Sec: 10 V. @ 13 Amps. For use w/803's, 304TL's or other 5 or 10 Volt Fil. Xmtg tubes. Good for 872A rectifiers. New. V. insul: 10,000 VAC. **$13.95.**
- **Dual Fil. Xfmr. (O.F.)** Pri: 110 VAC @ 60 CPS. Sec: 6.3 VAC @ 12 Amps. 6.3 VAC @ 6 Amps. Wt: 6¼ lbs. Stk #20C-4933. **$2.00.**
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- **Oil Xmtg Cap. 8 Mfd. 1500 VDC W.** Wt: 2½ lbs. Sck #KS8545. **$3.00.**
- **G.E. Pyranol Cap. 1 Mfd. @ 6000 VDC.** Net Wt: 8¼ lbs. **$4.95.**
- **Battery Charger 2 Mtrs** 6/12 V. Signal Corp. PE128A. **$35.00.**
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- **Hickok Type Tube Tester, Model 547. $55.00.**
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- **VHF Transmitter.** Perfect for 2 meter and/or 1¼ meter conversion. Late, modern design. Uses two 6201's into single Amperex 6360 twin triode. Xmtr only 4"x4"x11". Only 3¾ lbs. Complete with 10½" chrome antenna. Furnished complete with A and B Battery Pack and connection cable, and schematic & conversion info. Battery wt: 35 lbs. (water-activated battery). Sale price **$15.00.**
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- **LAG-1 RF Sig. Gen.** 1,200-4,000 Mc. 115 VAC. 60 CPS. **$395.00.**
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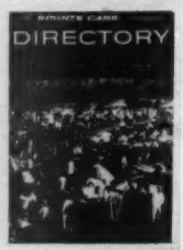

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unit is factory aligned on the additional channel for easy field installation of the second crystal if desired.

RADIO-FIELD INDICATOR

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y. is now offering a low-cost, portable radio-field indicator which requires no batteries, power-line connection, or transmitter connection.

The unit provides a continuous performance check by measuring the r.f. field generated by any marine, mobile,

or fixed transmitter operating on frequencies between 100 kc. and 250 mc., irrespective of power.

The TM-14 features a 200-μa. meter movement with variable sensitivity control. A phone jack at the rear of the indicator accepts earphones for aural monitoring. The antenna extends from 3¼" to 10¾". The meter measures 3⅛" x 2¼" less antenna. —30—

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CALENDAR of EVENTS

Sun	Mon	Tue	Wed	Thu	Fri	Sat
						5
						12
						19
						26

MAY 1-7
87th Convention of the Society of Motion Picture and Television Engineers. Ambassador Hotel, Los Angeles.

MAY 2-3
Company Member Conference. Sponsored by American Standards Assn. Sheraton Hotel, Philadelphia.

MAY 2-5
URSI-IRE Spring Meeting. Sheraton Park Hotel and National Bureau of Standards, Washington, D. C.

MAY 2-4
Twelfth Annual National Aeronautical Electronics Conference. Sponsored by Dayton Section of IRE. Biltmore and Miami-Pick Hotels, Dayton, Ohio.

MAY 3-5
1960 Western Joint Computer Conference. Sponsored by IRE, AIEE, and ACM. Fairmont Hotel, San Francisco.

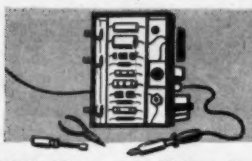
MAY 4-14
U.S. World Trade Fair. New York Coliseum, New York City.

MAY 9-12
ISA Conference and Exhibit. Sponsored by Instrument Society of America. Civic Auditorium, San Francisco, California.

MAY 10-12
1960 Electronic Components Conference. Sponsored by AIEE, IRE, and WEMA, Washington Hotel, Washington, D. C.

MAY 16-18
1960 Electronic Parts Distributors Show. Sponsored by Electronic Industry Show Corp. Conrad Hilton Hotel, Chicago.

Two hundred amateur radio operators assembled recently in San Mateo, California to honor John Reinartz, K6BJ, upon his retirement as manager of the Amateur Service Department of Eitel-McCullough, Inc., after more than 50 years in radio as amateur, military man, and businessman. Herbert Hoover, Jr., W6EV, acted as toastmaster at the banquet. Shown in the photo below are: Lt. General Francis H. Griswold, KØDWC, Vice-Commander SAC; William W. Eitel, president of Eimac and co-host with Jack A. McCullough; John Reinartz, the guest of honor; and Herbert Hoover, Jr. Mr. Reinartz is "retiring" to have more time to devote to his hobby of amateur radio—his interest since 1908.



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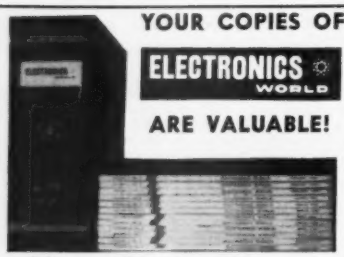

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